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RAPID TRANSIT FOR NEW YORK.

The plan recently submitted by ex-Mayor Hewitt for a rapid transit system for New York embodies the underground feature, and has met with almost unanimous approval from the public. As any underground road will almost undoubtedly entail the use of electricity as the motive power, all interested in the electrical industries have a distinct interest in furthering the Hewitt plan, and in assisting to get rid of the present incompetent Rapid Transit Commission, which is a stumbling block in the way of the adoption of any system. While the motives of the members of the commission may be proper, and the suspicion that they are mere puppets of the present elevated railway interests may be unjust, the fact remains that the public has lost all confidence in them, and their official existence is a menace to the success of any competent scheme of rapid transit. The adoption of electrictiy as the motive power for the proposed Hewitt system would give an impetus to that method of traction that would have a far-reaching effect, and hasten its adoption in other cities where its use has been discussed. The Rapid Transit Commission have made the statement that they have no power to carry out a plan like Mr. Hewitt's, but as they have the power to adopt an objectionable plan, the Legislature should lose no time in abolishing this unpopular body, and then proceed to give the attention to the scheme proposed which it merits and the needs of the public demand.

SOME MORE PHOTOMETRIC MEASUREMENTS.

A professor recently reported to the Brooklyn city government the result of his measurements of city street arc lights, which presumably were made in the open air, with the lamps *in situ*. He reports that the first five lamps measured varied from 976 to 1,634 candle power, and that of fourteen others but four showed the power required by contract; the lights on Eighth avenue and North street were found so poor that no measurements were taken; of 20 lamps in the Eastern District, only three were found to have a candle power in excess of 900, the others varying from 452 to 895 candle power. The question arises why the professor reported, for example, the 452-c. p. ray as the candle power of a particular lamp, and not the 699-c. p. ray, or the 1,299-c. p. ray; or, on the other hand, why he measured the 1,634-c. p. ray of one of the first lamps instead of its 452-c. p. ray, as in the case of one of the subsequent ones. Why didn't he give all the rays a chance and report, for instance, that the lamps whose vertical rays he measured had no candle power? To offset this report, the electric light company affected by it should secure the services of the professors who at Buffalo measured the candle power of 2,000-c. p. (nominal) lamps and reported that the "average candle power of the lamps" was above 2,000 c. p.—meaning, probably, the average candle power of the maximum ray. The electrical public is to be congratulated that the recent action of the Electric Light Convention, defining candle power in terms of watts, will put an end to these photometric absurdities.

THE FARADAY-MAXWELL-HERTZIAN EPOCH.

In this issue we print a third section of Dr. Pupin's remarkably interesting and able review of the evolution of the Faradic theory of electrical action, the great work of Maxwell being taken up in the present installment. It will be noted that Dr. Pupin has chosen the philosophical method of

treatment, tracing the gradual growth of the various fundamental ideas and showing the manner in which they were treated by the different workers in this great field. A lesson taught by the story of Faraday and Maxwell is the great importance of keeping the mind free from the trammels of authority and of academic methods of thought. It is perhaps not too much to say that the great conceptions of Faraday would never have had birth had he received a regular academic training, and that if Maxwell had not adopted the course he did in absorbing the knowledge of Faraday before submitting his mind to the influence of orthodox authority, his subsequent labors might have had but a tithe of their great value. Herbert Spencer, it is known, ascribes his original methods of thought to his escape from the orthodox course of mental training, and John Stuart Mill refers in strong terms to the danger of authority from its tendency toward the repression of originality. The history of thought shows that from Aristole to the present all great advances have been due to those who rebelled against the tyranny of authority, and yet these are the very ones whose influence, while freeing the mind from one bondage has only resulted in submitting it to another. While every one is not competent to question the conclusions of a master, yet all should hold as a right the privilege to apply the test of fact and experimented even to the theories of Maxwell.

A BOLD VENTURE IN ELECTRIC RAILROADING.

That electricity makes it possible and practicable to build a railroad where the use of horses is out of the question and the use of steam is impracticable and too costly, is shown very well in the new, bold project which is reported from Switzerland, that unique little country whose grand and beautiful scenery is one of the chief sources of revenue to the people—and requires no artificial protection. Permission has just been asked from that government to build an electric railroad to the top of the magnificent Jungfrau, one of the grandest, highest and most admired of the snowclad Alps in the Bernese group. Those who have never seen this mountain may obtain an idea of the difficulties involved when they consider that it is a jagged mountain, on which avalanches are so numerous that the traveler on the opposite hillls is often repaid by waiting to see one. Until not very long ago the ascent of this mountain was considered impossible, and a number of lives were lost in the numerous attempts, and even now it should be attempted only by expert climbers in company with expert guides, and requires two days for the round trip. To build a railroad on such a mountain is a project which only a Swiss would dare to make, and the able and fearless engineers which that little country has turned out leaves little doubt that the project can be carried out successfully, though we venture to predict not without the loss of lives in the attempt. Even the lower end of this proposed railroad, near the well-known and favorite resort, the Wengern Alp, is not very far below the eternal snow line, so that almost the entire road will be through the regions of the eternal snow fields; much of it, if not most of it, must therefore be tunnelled or protected from the frequent snowstorms and avalanches by a half tunnel under the solid rock. An isolated rocky prominence, 200 feet below the top and free from snow, is to form the upper terminal of the railroad, the rest of the journey to the top being made by an electric elevator, probably through a shaft. Some of the scant data at present at hand is given in our Digest. More than one scheme has been proposed to make the top of this mountain accessible to the numerous travelers whose nerve, muscle and purse are not equal to the requirements of the old-fashioned way of climbing this mountain. One of these, originating, we believe, in England, was to tunnel horizontally into the heart of the mountain, and from there up to the top by a vertical shaft. Electricity now makes it possible to adopt a more feasible and less expensive plan over a much more picturesque and attractive route, using neighboring waterfalls in place of expensive coal. As the lower end of the route is already accessible by rack and pinion railroads, an invalid will then be able to ride in his chair from any city of the Continent to the top of the Jungfrau.

ALTERNATING CURRENTS.

We have several times referred to the difficulty of students in following the analytical treatment of alternating currents, and pointed out the objections to this method from its excessive complexity when the form of the alternating current curve departs from the simple sine form, as it must necessarily do in practice. Another serious objection is the manner in which physical facts are masked in the analytical treatment and their practical bearing obscured. We have recently published a number of articles based upon rational methods of treating the subject, among which are those of Kennelly, Ryan and Patten, and which together form, from this point of view, perhaps the best contribution to the literature of the subject yet made, whether in periodicals or books. In this number we print the first section of the Convention paper of Mr. C. F. Scott, referred to in our last issue, which is a further contribution of the same character, and one that will appeal particularly to practical central station men. It should be borne in mind that while all of the alternating current effects enumerated are of interest to those who wish to have an intelligent idea of alternating current working, many, such as hysteresis, resonance, Ferranti effect, capacity, etc., will have no bearing on every day practical work in connection with ordinary installations. On the other hand, the phenomena of self and mutual induction are of the greatest practical importance, and cannot be neglected. Perhaps every one who has had to do with alternate current wiring, in which tables calculated for continuous currents were used, has noticed singularities in drop. With the usual frequency employed in this country and with the large wires sometimes necessary in alternating current wiring, the inductive effect cannot be neglected, and it will be useful to the reader to apply to the drop curves in Mr. Scott's paper some data from an actual installation, that this point may be impressed upon his mind. The inductive drop, it is well to remark, should not be confounded with that caused by a true ohmic increase of resistance, due to the unequal distribution of an alternating current in a conductor. The increase of drop from the latter cause is absolutely negligible with conductors of the sizes ordinarily used and with commercial frequencies. The manner in which the inductive drop is affected by the disposition of conductors is clearly shown in the paper, and hereafter there will be no excuse for installing alternating current lines without reference to this point, as has heretofore almost universally been done. Some months ago an article in these columns on the points above referred to brought forth a number of inquiries from central station managers, from which it appeared that the effects of impedance, important as they are, were then almost, if not entirely, unknown to practical men. The paper of Mr. Scott is, therefore, a most timely one, and will, from the clear and simple manner in which the subject referred to is treated, as well as from the other practical information contained in it, be a boon to central station men, and of unusual value to students as a first introduction to a branch of electricity that is almost daily becoming of greater importance. Taken in connection with the articles of Prof. Ryan, now being published serially in our columns, and the paper of Dr. Bell, the second section of which appears in this number, and the recent articles of Kennelly and Patten, the reader may obtain ideas and information in regard to alternating current working which he could not get from all the books thus far published.

The Faraday-Maxwell-Hertzian Epoch.—III.

By M. I. PUPIN.

Faraday did not form a new school of physicists during his lifetime. His ideas were too original, his view of the phenomena of electricity was far too different from the generally accepted views of his time to gain him a large following, even among his own countrymen. His generation recognized the supreme value of his discoveries; it failed to appreciate the full meaning of the aims of his speculation. It was reserved for the next generation to grasp this meaning and to explain it in terms of the language of the existing mathematical theories. It was by no means an easy task for the next generation to perform. It required a peculiarly constituted mind; a mind combining in itself the mental qualities of a physical investigator and a mathematician. Maxwell was a perfect representative of this rare combination. When his attention was first drawn to Faraday he was fortunately still out of the hearing distance of the seductive voice of the old "direct-action-at-a-distance theories"; I say fortunately, for, as Hertz[1] observed once in his characteristic way, he who once strayed into the magic circle of these remained a captive there. Maxwell was born in June, 1831; Faraday announced his first discovery in electromagnetic induction in November of the same year. William Thomson, now Lord Kelvin, was then only ten years old. "Before I began the study of electricity," said Maxwell,[2] "I resolved to read no mathematics on the subject till I had first read through Faraday's "Experimental Researches on Electricity." I was aware that there was supposed to be a difference between Faraday's way of conceiving phenomena and that of the mathematicians, so that neither he nor they were satisfied with each other's language. I had also the conviction that this discrepancy did not arise from either party being wrong. I was first convinced of this by Sir William Thomson, to whose advice and assistance, as well as to his published papers, I owe most of what I have learned on the subject."

Maxwell was barely twenty when he first took up the study of Faraday. Sir William Thomson was twenty-four when he first announced, in 1845, in a paper "On the Elementary Laws of Statical Electricity" ("Papers on Electrostatics and Magnetism," article II.), his strong inclination toward the view of Faraday. But Thomson was too far advanced at that time in the great scientific activity of those days. He played too prominent a part in the establishment of the principle of conservation of energy and the mechanical theory of heat to allow Faraday's researches to occupy his attention completely, although many an investigation of that date shows clearly the strong influence which Faraday's discoveries and views exerted upon him. Maxwell threw his whole young heart and soul into his study of Faraday's "Experimental Researches." It was only a year after he took his degree at Cambridge when his first essay "On Faraday's Lines of Force" appeared. By considering the motion of an imponderable, incompressible fluid, Maxwell drew in this essay a masterly picture of Faraday's lines of force, showing their bearing upon the various phenomena of electricity, and added to it a mathematical commentary of rare elegance. This picture makes the whole region covered by Faraday's researches appear in sharply defined outlines, especially to the eyes of those who prefer to view things in the intense light of mathematical analysis. "We have all acquired," said Maxwell in this essay, "the mathematical

[1] Hertz on "The Relation Between Light and Electricity." Lecture delivered before the 62d Convention of Naturalists and Physicians at Heidelberg, 1890.

[2] **Treatise on Electricity and Magnetism.** Vol. I., preface, p. 9.

conception of * * * attractions. We can reason about them and determine their appropriate forms or formulae. These formulae have a distinct mathematical significance, and their results are found to be in accordance with natural phenomena. There is no formula in applied mathematics more consistent with nature than the formula of attractions, and no theory better established in the minds of men than that of the action of bodies on one another at a distance. The laws of the conduction of heat in uniform media appear at first sight among the most different in their physical relations from those relating to attractions. The quantities which enter into them are *temperature, flow of heat, conductivity.* The word *force* is foreign to the subject. Yet we find that the mathematical laws of the uniform motion of heat in homogeneous media are identical in form with those of attractions varying inversely as the square of the distance. We have only to substitute *source of heat* for *centre of attraction, flow of heat* for *accelerating effect of attraction* at any point, and *temperature* for *potential,* and the solution of a problem in attractions is transformed into that of a problem in heat."

"This analogy between the formulae of heat and attraction was, I believe, first pointed out by Prof. William Thomson." * * *

"Now, the conduction of heat is supposed to proceed by an action between contiguous parts of a medium, while the force of attraction is a relation between distant bodies, and yet, if we knew nothing more than is expressed in the mathematical formulae, there would be nothing to distinguish between one set of phenomena and the other."

* * * * * * * *

"It is by the use of analogies of this kind that I have attempted to bring before the mind, in a convenient and manageable form, those mathematical ideas which are necessary to the study of the phenomena of electricity."

* * * * * * * *

"By referring everything to the purely geometrical idea of the motion of an imaginary fluid, I hope to attain generality and precision, and to avoid the dangers arising from a premature theory professing to explain the cause of phenomena. If the results of mere speculation which I have collected are found to be of any use to experimental philosophers, in arranging and interpreting their results, they will have served their purpose, and a mature theory, in which physical facts will be physically explained, will be formed by those who, by interrogating Nature herself, can obtain the only true solution of the question which the mathematical theory suggests."

These remarks contain what may be called the *Maxwellian programme* of reformation of the science of electricity. *The use of analogies forms the fundamental feature of this programme.* Maxwell remained faithful to it throughout his whole life. But it must be well understood that he did not remain faithful to any particular analogy. They were all temporary structures to be torn down like the scaffolding of a new edifice as soon as they had done their duty. The first analogy was the notion of an imponderable, incompressible fluid. By means of the tubes of flow he explained graphically what Faraday meant by lines of force. Having once clearly defined by this particular analogy the idea of lines of force, he applied it to the "theory of dielectrics," "of permanent magnets," "of paramagnetic and diamagnetic induction," of "magnecrystallic induction," etc., etc. When he came to the application of the idea of lines of force to the discussion of electric currents produced by induction, there his analogy seemed to fail him. It could give him no picture of what Faraday called the *electrotonic state.* This circumstance undoubtedly caused him considerable disappointment, for it is well known that Maxwell looked upon this state as one of the fundamental quantities in the electrical science and made it appear in the list of his fundamental equations. The discovery of a mathematical function representing in every respect Faraday's electrotonic state seems to have been considered by Maxwell as the crowning effort of his first essay. He called it the electrotonic intensity; in his later writings he changed the name, but this very change reminds us that he had changed the analogy, by means of which he gradually unravelled the mysteries of Faraday's visions in electricity. Faraday's electrotonic state of a closed linear conductor is known to-day among engineers as the number of lines of force interlinked with the conductor; hence the rate of variation of that state is the same thing as the rate of change of the interlinked lines of force, and therefore it is equal to the electromotive force induced in the conductor. But this is not exactly the same thing as Maxwell's electrotonic intensity, and the distinction seems to me to be exceedingly important. According to Maxwell, and Maxwell interpreted Faraday, that electromotive force is induced in the space occupied by the linear conductor whether the conductor be there or not; hence it must be due to some process going on in every element of that space; the presence of a conductor there offers only a convenient means of measuring that electromotive force by simply connecting the ends of the conductor to an electrometer. To give a mathematical expression to the process going on in every element of the space occupied by the wire, when there is a variation of the magnetic lines of force, Maxwell discovers a function, the electrotonic intensity, which has definite numerical values and definite directions at every element of the wire, and whose rate of variation in the direction of the elements equals the electromotive force induced in that element. The components of this function he calls *electrotonic functions* or *components of electrotonic intensity.*

"We have * * * obtained in the(se) functions," said Maxwell, "the means of avoiding the consideration of the quantity of magnetic induction which *passes through* the circuit. Instead of this artificial method, we have the natural one of considering the current with reference to quantities existing in the same space with the current itself."

Some physicists, and among them Hertz,[3] have objected to the presence of the vector potential in Maxwell's fundamental equations on the ground that such equations should express relations between experimentally measurably quantities, and not between purely mathematical functions like the vector potential. Hertz eliminated the vector potential from his representation of the Faraday-Maxwell theory of electricity; but it seems that this very elimination takes away the warm colors from the picture which Hertz in his theoretical writings gave us of the ideas of Faraday and Maxwell. In a note appended to a later essay, Hertz acknowledged that he did not consider very carefully all of Maxwell's writings when he wrote the essays named in the foot note below. His principal source of information concerning Maxwell's theory of electricity was the great treatise. It would naturally follow, then, that the full bearing of the vector potential upon Maxwell's theory of electricity escaped his eagle eye. This bearing is somewhat obscured by the vast amount of material contained in the treatise, which has little or nothing to do with the Faraday-Maxwell theory of electricity. The vector potential (which is only another name for the electrotonic intensity), giving, as it did, a mathematical expression to the belief in the real physical existence of what Faraday called the electrotonic state, was considered by Maxwell as one of the most important, if not the most important, quality in the whole range of physical quantities discovered by Faraday. It exists in a conductor even if there be no observable force acting between this conductor and the surrounding magnetic field; as, for instance, when a conductor through which no

[3] Electric Waves, article XIII.
[4] Electric Waves, article XIV., note 35.

current flows is placed in a constant magnetic field. It manifests itself just as the existence of matter manifests itself to our senses; that is, through a reaction, similar to the inertia reaction of matter, with which the conductor opposes a change in its electrotonic state. This reaction is measured by the induced electromotive force. Maxwell saw clearly that the experimental proof of the actual existence of the electrotonic state meant a severe blow to the direct-action-at-a-distance theory and an approach to the realization of Faraday's visions, to which I referred above. For since there is no apparent force acting upon a conductor through which no current flows when that conductor is in the vicinity of a magnet, it follows that the old theory which starts with the fundamental laws of action of forces between bodies will expose all its weakness when it attempts to account for the current induced in a neutral conductor. He had no confidence in his own experimental skill at that time. "I hope," said he, in the essay under consideration, "to render it evident that I am not attempting to establish any physical theory of a science in which I have hardly made a single experiment * * * " But he as much as assured the readers of his essay that he would assist the experimental investigation to complete what Faraday had left unfinished, and that is to produce all the necessary "experimental data for the direct proof of the unknown state."[5] In what the promised assistance was to consist may be gathered from the following lines of the same essay:[6] "In this outline of Faraday's electrical theories, as they appear from a mathematical point of view, I can do no more than simply state the mathematical methods by which I believe that electrical phenomena can be best comprehended and reduced to calculation, and my aim has been to present the mathematical ideas to the mind in an embodied form as systems of lines or surfaces, and not as mere symbols, which neither convey the same ideas nor readily adapt themselves to the phenomena to b explained. *The idea of the electrotonic state, however, has not yet presented itself to my mind in such a form that its nature and properties may be clearly explained without reference to mere symbols,*[7] and, therefore, I propose in the following investigation to use symbols freely and to take for granted the ordinary mathematical operations. *By a careful study of the laws of elastic solids and of the motions of viscous fluids I hope to discover a method of forming a mechanical conception of this eleetrotonic state adapted to general reasoning.*[8] (See Prof. W. Thomson "On a Mathematical Representation of Electric, Magnetic and Galvanic Forces," "Canb. and Dub. Math. Jour.," January, 1847.)

The reference to Thomson's paper is made clearer in the course of the essay by the following statement:[8] "With respect to the history of the present theory, I may state that the recognition of certain mathematical functions as expressing the 'electrotonic state' of Faraday and the use of them to express electrodynamic potentials and electromotive forces is, as far as I am aware, original; but the distinct conception of the possibility of the mathematical expressions arose in my mind from the perusal of Prof. William Thomson's papers 'On a Mathematical Representation of Electric, Magnetic and Galvanic Forces' * * * and his 'Mathematimatical Theory of Magnetism,' 'Philosophical Transactions,' Part I., 1851, article 78," etc. One more quotation from the same essay will suffice to complete the demonstration of the importance which in his first essay and in all his later essays Maxwell attached to the electrotonic state. He closes in this essay his mathematical discussion of this state as follows: "The discussion of these functions[9] would involve us in mathematical formulae, of which this paper is already too full. It is only on account of their physical importance as the mathematical expression of one of Faraday's conjectures that I have been induced to exhibit them at all in their present form. By a more patient consideration of their relations, and with the help of those who are engaged in physical inquiries, both in this subject *and in others not obviously connected with it,*[10] I hope to exhibit the theory of the electrotonic state in a form in which all its relations may be distinctly conceived without reference to analytical considerations."

To sum up briefly: Maxwell's first essay on Faraday's view of the electric, magnetic and electromagnetic phenomena contains, first, the programme of the method by means of which he proposed to formulate ultimately Faraday's conjectures and speculations into a physical theory of electricity. The introduction of physical analogies as aids to mathematical reasoning forms the characteristic feature of this programme. Second, it contains the first of Maxwell's analogies; that is, the analogy of the steady flow of an imponderable, incomprehensible fluid. This analogy solves a twofold purpose: on the one hand it gives a clear geometrical picture of Faraday's lines of force, and on the other hand, it demonstrates that phenomena which are reducible to actions and reactions of the contiguous parts of a continuous medium can lead to the same relations which are obtained by applying Faraday's idea of lines of force to the interpretation of the phenomena of statical electricity, permanent magnetism, magnetism of induction, uniform galvanic currents and electromagnetism. Third, it calls our attention to the great importance which Maxwell attached to the new state of matter discovered by Faraday, the so-called electrotonic state, in consequence of which a magnetic field reacts against external influences which tend to change it, just as a body reacts in consequence of its inertia; it gives a mathematical expression for this state in form of the so-called electrotonic intensity, a vectorial quantity which varies from point to point of a circuit, both in direction and in intensity, and whose rate of time variation along any element equals the electromotive force induced in that element by the variation. Fourth, it contains Maxwell's promise of a new analogy in which a mechanical conception of the electrotonic state, adapted to general reasoning, will be exhibited by means of the behavior of elastic solids and the motion of viscous fluids. A reference to William Thomson's famous essay of 1847 gives an intimation of the probable form of the new analogy.

(To be continued.)

[5] "On Faraday's Lines of Force," Scientific papers of Maxwell, vol. 1., pp. 188-189.
[6] p. 187.
[7] These words are put in Italic by the writer for obvious reasons.
[8] p. 209.
[9] The electrotonic functions.
[10] These words I choose to put in italics, because they seem to suggest that Maxwell at that time already had the electromagnetic theory of light in his mind's eye.

Belt Preservative.

The following empirical formula for a machine belt preservative is due to "L'Industrie": Warm in a covered vessel to a temperature of 50° C., 1 kilogramme of essence of India rubber broken up into pieces and mixed with 1 kilogramme of essence of turpentine. After the rubber has melted, add 800 grammes of colophone; stir until this too is dissolved, then add 800 grammes of yellow wax. In another vessel put 3 kilobrammes of cod liver oil, and 1 kilogramme of tallow; heat this mixture until the tallow melts, and then pour it into the first vessel, stirring continually until the mass cools and solidifies. Belts, the working faces of which are occasionally treated with this compound, are said "to acquire greater solidity, and slipping at the pulleys is avoided."

Telegraphing Without Wires.

Mr. Preece, in a recent paper, gave it as his opinion that it would be quite easy to speak between France and England across the Straits of Dover, without any metallic vonnection.

Polyphase Transmission.*

BY CHAS. F. SCOTT.

ALTERNATING CURRENT PROBLEMS.

THE alternating current when first introduced for lighting presented many new problems to the electrical engineer. Numerous difficulties and dangers were predicted by the theorist, but in ordinary service most of these have fortunately lain dormant. These difficulties are apt to appear, however, when alternating current work is attempted on a large scale. The introduction of large units, heavier currents, higher potentials or power service is apt to increase the effects of self-induction and capacity so that they will now demand careful consideration. The impetus which electrical engineering is receiving from the introduction of the polyphase system, which brings with it large units and long distances, naturally directs attention to the general problem of alternating current transmission and distribution.

A complete and exhaustive solution of this problem is by no means a simple one, and the attempted solutions generally lead to formulae and diagrams which are possibly even more perplexing than the phenomena. If even the electrician who devotes all his energy to new problems can scarcely keep abreast of the times, it is not surprising that the practical engineer and station manager become perplexed and confounded at the apparently erratic phenomena observed in practice or described in print. Theoretical articles appear on variation in wave form, harmonics, so-called Ferranti effects, increased resistance in conductors with alternating currents, hysteresis, peculiar magnetic circuits, resonance, oscillations, lag, capacity, self-induction. Many of these articles, although evidently intended to be of service in engineering, show apparently no adequate appreciation of the practical bearing and relation of the subjects treated. Consequently the average engineer becomes bewildered and perplexed, and concludes that theoretical explanations are of little value to the practical man. There are, however, many of great practical importance, which admit of fairly simple statement and explanation. The particular element to be considered in the present paper is the transmission circuit.

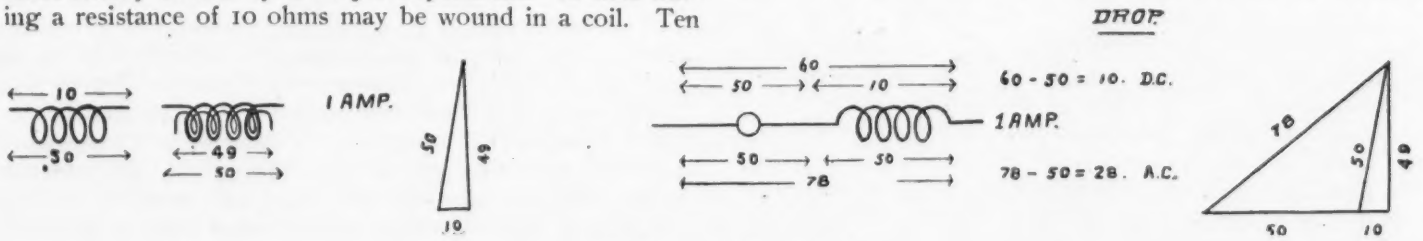
EXPERIMENTS ILLUSTRATING SELF-INDUCTION.

One of the fundamental characteristics of alternating current work is self-induction. The effect of self-induction is most readily shown by a simple experiment. A wire having a resistance of 10 ohms may be wound in a coil. Ten volts will send a continuous current of 1 ampere through this coil. An alternating current of a certain frequency will require 50 volts for producing 1 ampere through the same wire (Fig. 1a). In the diagrams the numbers above the circuit are for continuous current and those below are for alternating current. If a 1-ampere, 50-volt lamp be placed in series with the coil and a current of 1 ampere be passed through the two in series, the E. M. F. required for continuous current is 10 volts on the coil and 50 volts on the lamp, or 60 volts across the circuit, and the E. M. F. required for alternating current is 50 volts across the coil and 50 volts across the lamp, which gives, not 100 volts, but 78 volts measured across the two in series (Fig. 2). If two lamps be placed in multiple and connected in series with the coil, 2 amperes will require for continuous current 20 volts on the coil and 50 volts on the lamps, or 70 volts across the circuit. For alternating current the E. M. F. on the coil is 100 volts and on the lamps 50 volts, and on the circuit across the two in series the E. M. F. is 120 volts (Fig. 3).

The two lamps which are in multiple may be placed in series with a second coil so proportioned that an E. M. F. of 50 volts will send 1 ampere alternating current through the combination, and a continuous current of 1 ampere would be caused by 35 volts. This combination may be treated as a unit and may be used to replace the single lamp in the above test (Fig. 2). If this combination be placed in series with the first coil, the E. M. F. required for sending the continuous current through the circuit will be 10 volts on the coil and 45 volts on the circuit. If the alternating current of 1 ampere be sent through the circuit, 50 volts will be required across the combination and 50 volts across the coil, the same as with the single lamp, but the E. M. F. across the circuit is no longer 78 volts, but has increased to 95 volts (Fig. 4).

The important facts to be noted in these experiments are: (1) That the sum of the alternating E. M. Fs. on the elements in series is greater than that required on the terminals; (2) that the alternating E. M. F. for supplying the lamps in series with a coil is greater than the continuous E. M. F., and (3) that the difference between the two becomes greater as the number of lamps is increased (Figs. 2 and 3). It is also to be noted (4) that if the same alternating current be supplied through a coil, first to a lamp alone and then to a combination, including lamps and a coil, a higher E. M. F. is required when the combination is used (Figs. 2 and 4).

These relations, which seem rather perplexing, may be illustrated in a very simple way by diagrams. In the case of the coil alone, in which 50 volts are required for producing 1 ampere alternating current and 10 volts for 1 ampere continuous current, these two E. M. Fs. may be represented by the hypotenuse and one side of the familiar right angle triangle. The remaining side represents the counter E. M. F. in the coil. If a second wire had been wound in this coil in parallel with the first, it would be found that when 1 ampere is passing there is an E. M. F. on the terminals of the second, or idle wire, of 49 volts (Fig. 1b). This E. M. F. is caused by the field produced by the alternating current. An equal E. M. F. is, of course, induced in the wire carrying the current, as the two wires occupy virtually the same position. This counter E. M. F. is seen to correspond with the third side of the triangle. Suitable measurements would show that this counter E. M. F. occurs later than the current through the coil, and that its maximum value occurs when the current is passing through its zero. This relation is shown in the diagram by the 90-degree relation of the lines representing counter E. M. F. and the volts required for sending continuous current through the line.



FIGS. 1 AND 1b.

*A paper read before the National Electric Light Association, Washington, D. C.

SELF-INDUCTION IN CIRCUITS.

An ordinary circuit may be considered as a choke coil in which there is a single turn. The action in this case is very similar to that illustrated above with a coil of many turns. The effect of self-induction in a circuit may be most

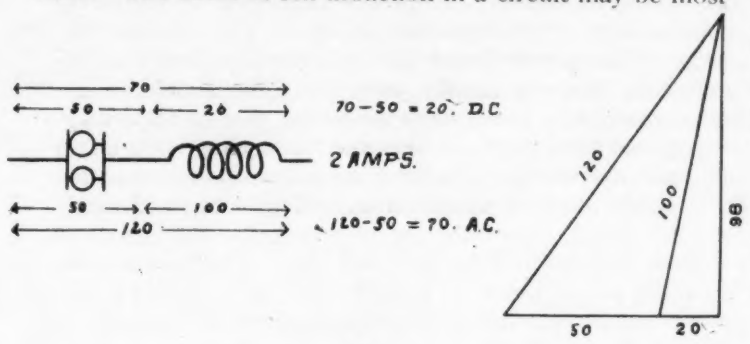


FIG. 3.

readily understood by some simple diagrams. A current of say 5 amperes is delivered at 100 volts over a circuit of one-fifth of an ohm resistance. The self-induction of the circuit is such that 5 amperes generate a counter E. M. F. of 10 volts. Both continuous and alternating currents are used, and the generator E. M. F. is in each case adjusted to give 100 volts at the load.

The load consists, first, of five incandescent lamps. A coil of high self-induction is then added, which increases the current from 5 to 5.1 amperes. One of the lamps is then cut out and replaced by coils of such a self-induction as to give a total of 5 amperes. Then all of the lamps are cut out and coils substituted of such a number as to take 5 amperes at 100 volts. The E. M. F. required on the generator and the resulting drop, or difference of E. M. F., at the dynamo and at the load are given in the diagrams and in the following table:

	Continuous Current.	Alternating Current.			
	Fig. 5.	Fig. 6.	Fig. 7.	Fig. 8.	Fig. 9.
Current in line.....	5	5	5.1	5	5
Current in lamps.....	5	5	5	4	0
Current in coils.....	0	0	1	3	5
E. M. F. on load.....	100	100	100	100	100
E. M. F. on line.....	1	10	10	10	10
E. M. F. on generator....	101	101.5	102.5	106	110
Drop—total	1	1.5	2.5	6	10

It is to be noted that with exactly the same circuit for supplying five lamps with the same amperes at the same E. M. F. there is an increase of drop between generator and load when continuous current is replaced by alternating current. This drop is much less than the volts required for

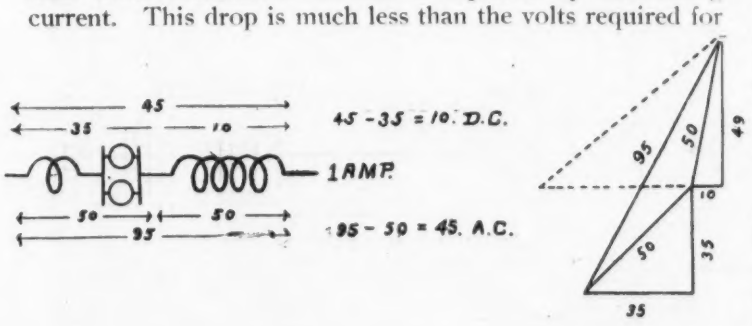


FIG. 4.

sending the alternating current through the line, and it, moreover, increases enormously as the load becomes even slightly inductive. Thus, when the current is increased only 2 per cent. (from 5 to 5.1 amperes, Figs. 6 and 7) by the addition of inductive load to the lamp load, the increase of drop due to self-induction is increased from 1-2 per cent. to 1 1-2 per cent., or an increase of threefold. When the load consists of four lamps and coils are added in multiple to take a total of 5 amperes, or the same as that taken by the five lamps from the generator, the drop is four times the drop when five lamps alone are in circuit. If the remaining four lamps be replaced by coils, the drop does not increase in proportion, but from 6 to only 10 per cent. The effect therefore of a slight self-induction in the load causes a much greater proportional drop than the presence of a large self-induction. A counter E. M. F. of 10 per cent. is not at all likely to occur in a 100-volt line carrying small current. The figures given, however, serve as an illustration of the percentage variations which are liable to occur in other parts of the system.

DROP IN CONTINUOUS AND ALTERNATING CURRENTS.

The word "drop" in continuous current calculations has a perfectly well defined meaning. In the case of the five lamps which take 5 amperes at 100 volts through a circuit of one-fifth of an ohm, as illustrated in Fig. 5, the drop is: (1) the difference between the E. M. F. at the generator and at the lamps, or 1 volt, which is 1 per cent.; (2) it is the E. M. F. required for sending the current through the line;

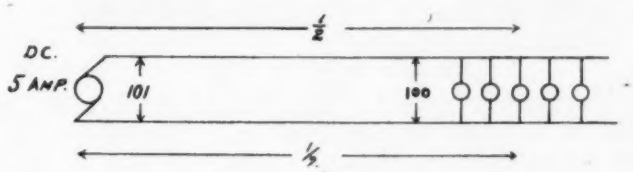


FIG. 5.—101 — 100 = 1.

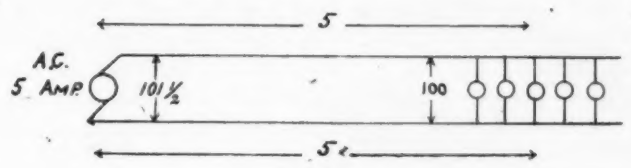


FIG. 6.—101½ — 100 = 1½.

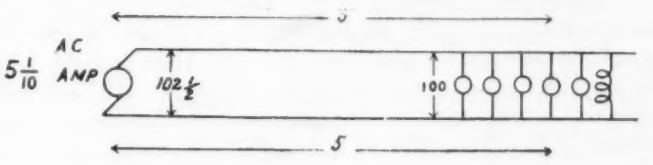


FIG. 7.—102½ — 100 = 2½.

this is equal to the current multiplied by the resistance, and is the E. M. F. which would be required for sending the current through the line if the load be short circuited; (3) a drop of 1 per cent. means also that the energy lost in the line is 1 per cent. of that delivered by the generator; (4) a loss of 1 per cent. in the line also signifies that the energy delivered is 1 per cent. less than that supplied by the generator.

In alternating current work the same uniformity does not exist; for example, in the experiments with the same five lamps and the same line: (1) the generator pressure was 101 1-2 volts, or 1-2 per cent. higher than that of the lamps; (2) the E. M. F. required for sending a current through a line short circuited is 10 volts, or 10 per cent.; (3) the energy lost in wires is $C^2 R$, or 5 watts, which is 1 per cent. of the energy when five lamps are supplied. If four lamps and low resistance coils are connected to the circuit, the energy delivered is, say, 400 watts and the loss is 1 1-4 per cent.; (4) if the coils alone are supplied and their combined resistance is equal to that of the circuit, or one-fifth of an ohm, then the losses in load and line are equal and the actual line loss is 50 per cent. The apparent energy at the generator is 550 watts (110 volts and 5 amperes) and the apparent energy delivered is 500 watts (100 volts and 5 amperes), so that the apparent loss is 9 per cent.

It is therefore evident that the several elements commonly

referred to as drop or per cent. loss with continuous current are so modified when alternating current is used that it is possible for no two of them to have the same value. Moreover, with alternating current, none of these elements may have the same per cent. value as that for continuous current on the same circuit.

LOSS AND REGULATION.

The two vital factors in the line are loss and regulation. The losses are $C^2 R$, and should be expressed in watts or horse power, or as a per cent. of the energy delivered to the

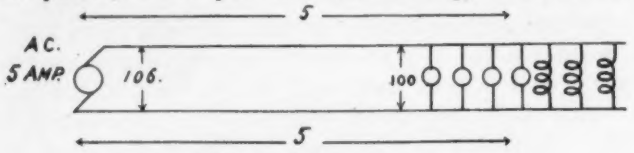


FIG. 8.—106 — 100 = 6.

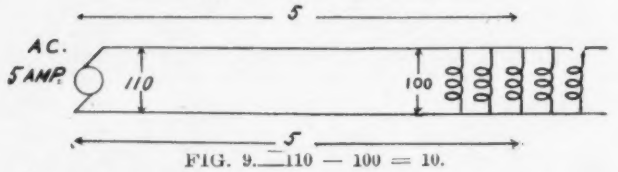


FIG. 9.—110 — 100 = 10.

line. The practical point in regulation is the difference in E. M. F. at the generator and at the load. When these two factors are known, it is generally immaterial what E. M. F. might be required for sending current through a short circuited line. The word "drop" is applied to the difference in E. M. F. between the generator and the load. The regulation is generally expressed in per cent. of generator E. M. F., but in this paper the E. M. F. at the load will be considered 100 per cent., as this is the element to be kept constant while the E. M. F. of the generator is variable, depending upon the load and other elements.

The regulation, or drop, in the alternating current circuit is dependent largely upon the counter E. M. F. of the line. The factors which practically determine the counter E. M. F. of the line are size of wire, distance between wires, length of circuits, frequency and current. Mr. A. E. Kennelly has given very complete curves (American Institute of Electrical Engineers, April, 1893) for determining the impedance of pole lines. The impedance factors given may be used for finding the current through a given line which is short circuited at one end when the E. M. F. and frequency are known. The impedance factor of the line for supplying five lamps, described above, is 10, as the alternating E. M. F. is ten times the continuous E. M. F. for the same current when the line is short circuited. The word "drop" is applied in Mr. Kennelly's article to the volts required for overcoming impedance in a circuit, and the impression that this is the same as the drop in continuous current circuits was not corrected in the paper, nor was this most practical point raised in the discussion. The relation between impedance and drop was, however, demonstrated mathematically in a communication after the meeting. The figures given in connection with the foregoing diagrams show very clearly that a circuit having the same impedance may have a drop between the generator and the load of from 1 1-2 to 10 per cent., depending upon the character of the load. Impedance, therefore, does not determine regulation.

CALCULATION OF DROP IN ALTERNATING CIRCUITS.

The regulation of a circuit is in general determined by two elements—the counter E. M. F. of the circuit and the self-induction of the load. The counter E. M. F. of a line depends upon the size of wire, the distance between wires, and increases directly as the length of the circuit, the current and the alternations. The counter E. M. F. of a line has been calculated for a number of cases, which are likely to occur in practice, and the results are given in Fig. 2. The drop, or difference, of potential between generator terminals and the load terminals, due to the counter E. M. F. of the line, depends, as has been shown, upon the self-induction of the load. The latter is best expressed by a power factor, or a factor by which the product of the amperes and volts giving the apparent energy must be multiplied to give the true power in watts. The power factor for incandescent lamps is 1.00, or the apparent energy is equal to the true energy. The power factor for converters loaded with incandescent lamps is usually over .99. The factor for unloaded converters varies from .50 to .80, and in open magnetic circuit converters, notably the "hedgehog," the factor may be as low as .05. The drop due to self-induction on the line (which, plus the ohmic drop, will give approximately the total drop), corresponding to various power factors of the load, is given in Figs. 12A and 12B. The curves show that if the power factor be 100 per cent., as it is with incandescent lamps, the inductive drops for various counter or inductive E. M. Fs. are .02 per cent. for 2 per cent.; .08 per cent. for 4 per cent.; .18 per cent. for 6 per cent.; .32 per cent. for 8 per cent.; .5 per cent. for 10 per cent.; 1.2 per cent. for 15 per cent., and 2 per cent. for 20 per cent. The curves show that the drop increases very rapidly at first if the power factor becomes less. These relations may be elegantly determined by a simple diagram on section paper ruled in tenths. Draw an arc through a quadrant with a radius of 100. At a distance from the centre on the horizontal, equal to the power factor of the load, erect a perpendicular and extend it to the arc. This line represents the counter E. M. F. of the load, and its value read directly on the scale gives the counter E. M. F. in per cent. of the E. M. F. upon the load. From the intersection of the arc draw a horizontal line outside the circle equal on the scale divisions to the per cent. in terms of the

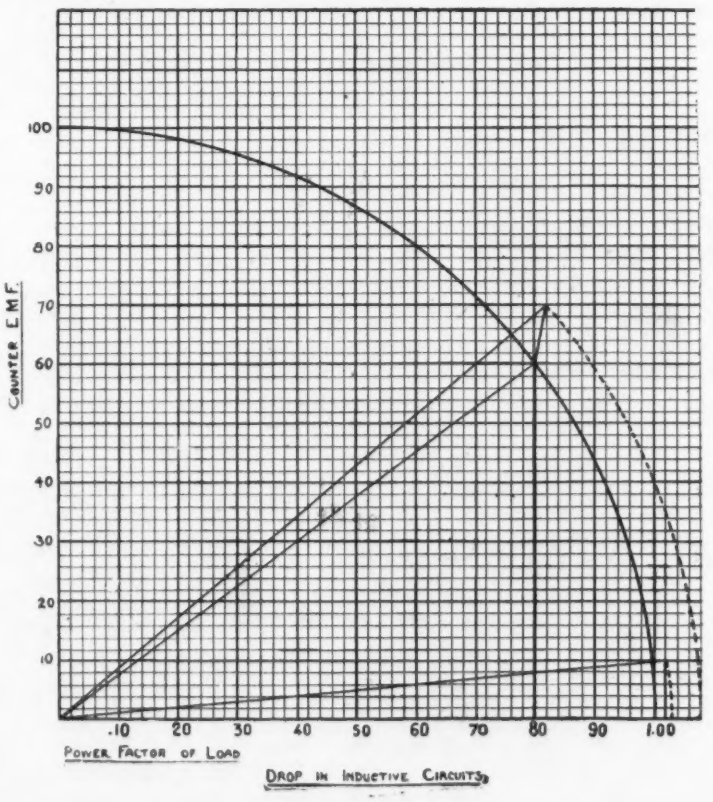


FIG. 10.

E. M. F. on the load which would be required for sending the normal amperes continuous current through the line resistance. From the end of this horizontal draw an upward vertical equal to the counter E. M. F. of the line expressed in per cent. of the E. M. F. on the load. A line from the centre to the upper end of this vertical represents in direction and magnitude the E. M. F. which must be

impressed on the circuit. If from the same centre an arc be drawn through this point to the base, the scale divisions on the base between the two areas measure the total drop caused by the line in terms of the E. M. F. on the load. See Fig. 1C.

SELF-INDUCTION IN TRANSFORMERS, ETC.

Self-induction exists in line, generators, transformers, secondary wiring, and sometimes in the load. In each case the effect of the self-induction upon regulation depends largely upon the self-induction of the total load which it supplies. Thus, the regulation of a generator depends upon the total

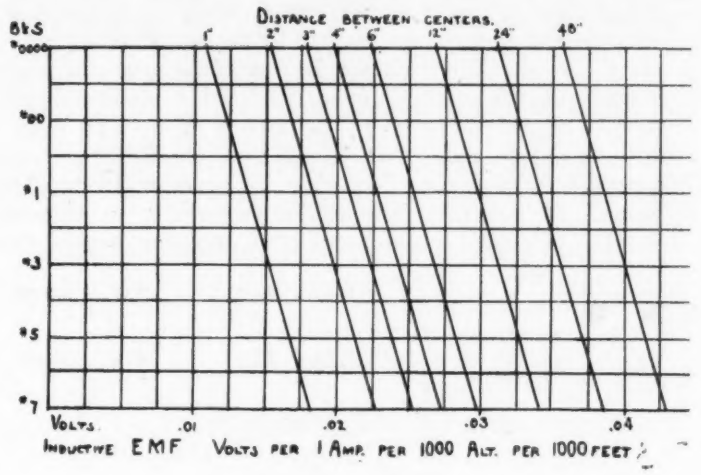


FIG. 11.

self-induction of the line, transformers and load. Again, the regulation of a line supplying transformers depends both upon the self-induction of the transformers, as well as that of the useful load. The same analysis and diagrams which have been used above in connection with the line will apply to the transformers and approximately to the regulation of the generator.

An ordinary transformer has a primary self-induction and

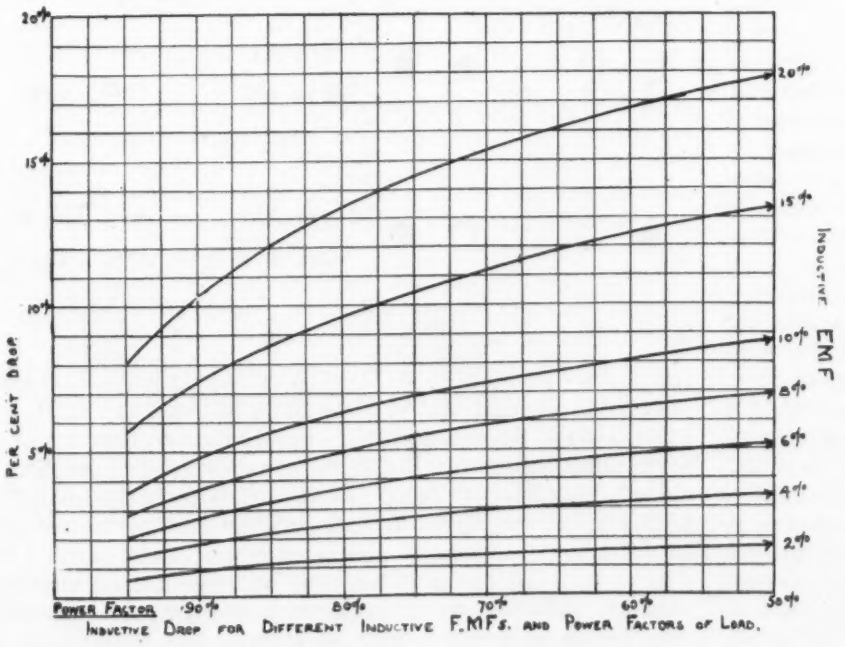


FIG. 12A.

a secondary self-induction and a mutual induction, which become a ready source of a very complicated and perplexing analysis when the complete action is described in theoretical terms. Practically, however, the action of the self-induction in the transformer may be expressed in a very simple way, and it is readily seen that this self-induction has a very important bearing upon the regulation of the transformer. The regulation of the transformer is very similar to that of a line, as explained above. If the secondary coil be short circuited, the E. M. F. on the primary may be adjusted so that the normal full load current passes through the apparatus. This E. M. F. corresponds very closely to the E. M. F. required for sending current through a short circuited line, and in ordinary transformers is practically equal to the counter E. M. F., and may be considered equal to it.

A transformer may be taken for experiment in which the E. M. Fs. are 1,000 volts and 100 volts. If 5 volts, or 1-2 per cent., is required for sending through the primary a continuous current equal to the normal full load current of the transformer, and if a similar E. M. F. in the secondary is 1-2 a volt, or 1-2 per cent., then the ohmic loss in the transformer is 1 per cent. and the drop in pressure at the secondary terminals between no load and full load will be 1 per cent. if the self-induction be negligible. If, however, there is a self-induction so that 100 volts, or 10 per cent., is required for sending the normal current through the primary when the secondary is short circuited, then the drop in pressure is in general greater than 1 per cent., depending principally upon the character of the load. The load may be non-inductive, as lamps, or it may be more or less inductive. The experiments described above, in which a line had the same per cent. ohmic and inductive characteristics as the converter just described, apply to the converter as well as to the line. The drop on such a converter, therefore, may vary from 1 1-2 to 10 per cent. when delivering its rated current. Arc lamps, or fan motors, will produce a very much greater drop than incandescent lamps. The power factor of an alternating current arc lamp varies considerably, but in a number of cases has been found between 85 and 90 per cent. The drop, when incandescent lamps are replaced by arc

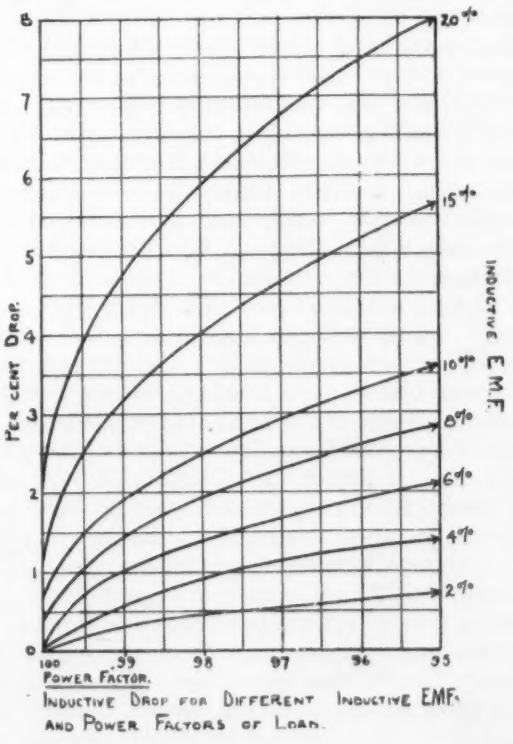


FIG. 12B.

lamps on the transformer just described, increases from about 1 1-2 to 5 or 6 per cent.

A secondary line, if it carry a large current, may have a counter E. M. F. of several volts. This may not be enough to increase appreciably the drop in the line between the

transformer terminals and incandescent lamps. But the transformer, however, delivers current to the secondary circuit and to the lamps, so that the regulation of the transformer may be affected by the self-induction of the secondary circuit. Cases have occurred in which transformers of a very old type possessing high self-induction were supplying very large secondary currents and the resulting drop in the transformers was increased several per cent. For example, a circuit of No. 0000 B. & S. wire supplying 100 amperes to 50-volt lamps at a distance of 100 feet has an ohmic drop of 2 per cent. The constant for counter E. M. F. of this circuit, if the wires be 6 inches apart, is .022. The volts at 16,000 alternations are $.022 \times 100 \times .1 \times 16 = 3.52$, or 7 per cent. of 50 volts. The inductive drop in the line corresponding to 7 per cent. is .25 per cent. The power factor of the aggregate service of the transformer is the second side of a right angle triangle, of which 7 is one side and 100 is the hypotenuse. This is 99.7, which is the power factor of the total load on the transformer. If the inductive E. M. F. of the converter be 10 per cent., the inductive drop is 1.2 per cent.; if 20 per cent., the inductive drop is 3.4 per cent., and if 30 per cent, the inductive drop is 7 per cent. The aggregate drop in the converter and secondary circuit in the latter case would be, say, 2 per cent. for ohmic drop in transformer, 2 per cent. ohmic drop in line, 7 per cent. inductive drop in transformer, and .25 per cent. inductive drop in line, or a total of 11.25 per cent. The necessary ohmic drop is 4 per cent. and the inductive drop resulting from self-induction in transformer and line is therefore 7.25 per cent. If the number of alternations be reduced to 7,200, the inductive drop would be reduced from 7.25 per cent. to 1 1-2 per cent.

ORDINARY TESTS UPON TRANSFORMERS.

The practical bearing of the self-induction of a transformer upon its regulation and the exact relation between the two does not seem to be clearly recognized, and even Dr. Hopkinson and Dr. Fleming, who have made very exhaustive tests upon transformers, comparing different methods of testing and different types of transformers, have not brought out this point. Attention is given to the exact form of the current wave, and measurements upon the iron losses are attempted within very close limits of error. Their measurements upon the regulation of the same transformer, however, vary from 2 per cent. to 2.4 per cent., or one measurement is one-fifth greater than the other. The presence of slight induction in the secondary load would have caused a very considerable increase, and it is probable that the difference in the measurements made were due to difference in the self-induction of the instruments used or in the load at the time the tests were made. No note is made of the effect of the self-induction of the load upon regulation, although regulation is one of the most vital points in the practical use of transformers. Even the temperature at which the drop was measured is not stated, although the resistance of a transformer when continuously working may be 20 per cent. greater than when cold. The elements of practical importance in a transformer are (1) the iron loss, in respect to the efficiency; (2) the regulation, in respect to the satisfaction of service; and (3) the temperature to which the insulation is subjected, as affecting the life of the transformer. In the ordinary test by theoretical men the iron loss is measured to a very high degree of refinement, although the iron loss in transformers is the one thing which cannot be controlled, and is certain to vary 10 or 15 per cent. in commercial manufacture of transformers of the same size. The wave form of E. M. F. on different dynamos, or the difference in form under different conditions of load on a circuit, may make the loss under different commercial conditions vary several per cent. This renders more refined measurements of no practical use unless the conditions are stated. The temperature of the iron also affects the loss. The full load efficiency is usually given as if it had a great deal of importance, whereas the losses in copper during 24 hours ordinarily amount to but a trifling per cent. of the total losses. The regulation and the temperature to which the insulation is subjected, and which it is able to stand, are generally not mentioned in reports of tests. The usual investigations and the papers published on the alternating current transformer may, perhaps, accurately express many facts in complicated formulae, but the practical bearing of these points in every day working seems to be totally ignored.

MUTUAL INDUCTION.

If two circuits be run on the same pole line they act as a transformer, in which one circuit carrying current may act as a primary and induce E. M. F. in the other as a secondary. If the latter circuit is connected with the same dynamo and is delivering current, its E. M. F. will be slightly raised or slightly lowered by the effects of the first circuit. Conversely, the second circuit will have similar effect upon its neighbor, raising or lowering its pressure by a slight amount. If the two circuits be connected to different dynamos which are running at slightly different speeds, then

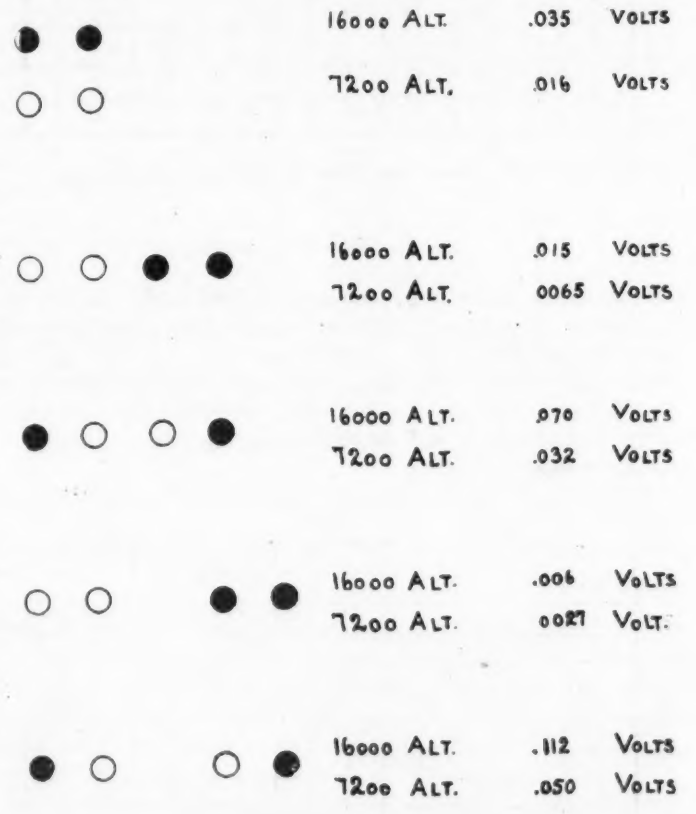

16000 ALT. .035 VOLTS
7200 ALT. .016 VOLTS
16000 ALT. .015 VOLTS
7200 ALT. 0065 VOLTS
16000 ALT. .070 VOLTS
7200 ALT. .032 VOLTS
16000 ALT. .006 VOLTS
7200 ALT. 0027 VOLT.
16000 ALT. .112 VOLTS
7200 ALT. .050 VOLTS

FIG. 13a, b, c, d, e.

the E. M. F. induced by one circuit upon the other will sometimes increase and at other times decrease the E. M. F. of the circuit, depending upon whether the two currents at a given moment are flowing in the same or in opposite directions. This fluctuation may cause variations in the intensity of the lights supplied. It is readily detected in the service of some central stations, and is of course most marked at time of full load, as the induction of one circuit upon another depends upon the strength of current carried. The fluctuation due to this action may be readily distinguished from that due to slipping of belts or irregularity in engine speed, as the induction effect is due to the difference in alternations between two machines, and the speeds of the two machines are apt to vary slightly from time to time, giving a gradual variation in the rate of fluctuation of the lamps. The fluctuation due to mutual induction of lines occurs only at the end of the line, and is not observed in the station, while the other causes affect the station lights also. The number of

volts E. M. F. set up in one circuit by a parallel circuit depends upon the current, the distance which the lines are parallel and upon the relative positions of the four conductors. The distance between wires may be six inches or six feet without affecting the mutual induction, provided the relative positions be unchanged. Several dispositions of circuits are shown in the accompanying Fig. 13, and the number of volts per thousand feet at 7,200 and at 16,000 alternations which are induced in either circuit by one ampere in the other are given in connection with each figure. The number of volts required for producing objectionable flickering in the light depends upon the voltage of the lamps in service, the efficiency at which they are run and the general surroundings in which they are placed, notably the relation of lamps to reflectors, white walls, etc., and the general disposition of the customer.

An E. M. F. of 1-2 per cent. induced in one circuit by another can in some cases be detected, and usually more than 1 or 2 per cent. will cause objectionable flickering.

METHODS OF REDUCING MUTUAL INDUCTION AND SELF INDUCTION.

The mutual induction is reduced by bringing the wires in each circuit close together and separating the circuits. The effect of this mutual induction may be neutralized by crossing one of the lines at its middle point, so that induction in the first half of the line is counteracted by the induction in the second half. It is readily noted that the effect of self-induction in a circuit is reduced as the wires are brought close together, or if each conductor be divided into several wires in multiple and separated. The effect of self-induction is diminished as the number of alternations is reduced. The following points are also to be noted in connection with inductive drop: If the power factor be nearly 100 per cent., the inductive drop increases as the square of the counter E. M. F. If the E. M. F. of the circuit be increased and the same power be delivered over the same circuit, the per cent. counter E. M. F. decreases as the square of the E. M. F. delivered, and the inductive drop decreases approximately as the fourth power. If the number of alternations be decreased, the counter E. M. F. decreases directly and the inductive drop decreases as the square. The inductive drop at 7,200 alternations is less than one-fourth of that for 16,000 alternations for ordinary power factors.

CAPACITY IN LINES.

The static capacity in ordinary lines is usually small, and its effect is not of importance unless the line be very long or the pressure be very high. The general effect of capacity in the line or of connecting condensers to the line is to lessen the current from the generator which is required for supplying inductive load and to reduce the drop due to self-induction. The use of condensers for this purpose may lead to very considerable gains in circuits where the self-induction of line or of load becomes considerable. If an inductive circuit or transformer supply current to condensers, the E. M. F. may increase instead of decreasing, as it does with inductive load.

(To be continued.)

The Electric Light in London.

(From our own Correspondent.)

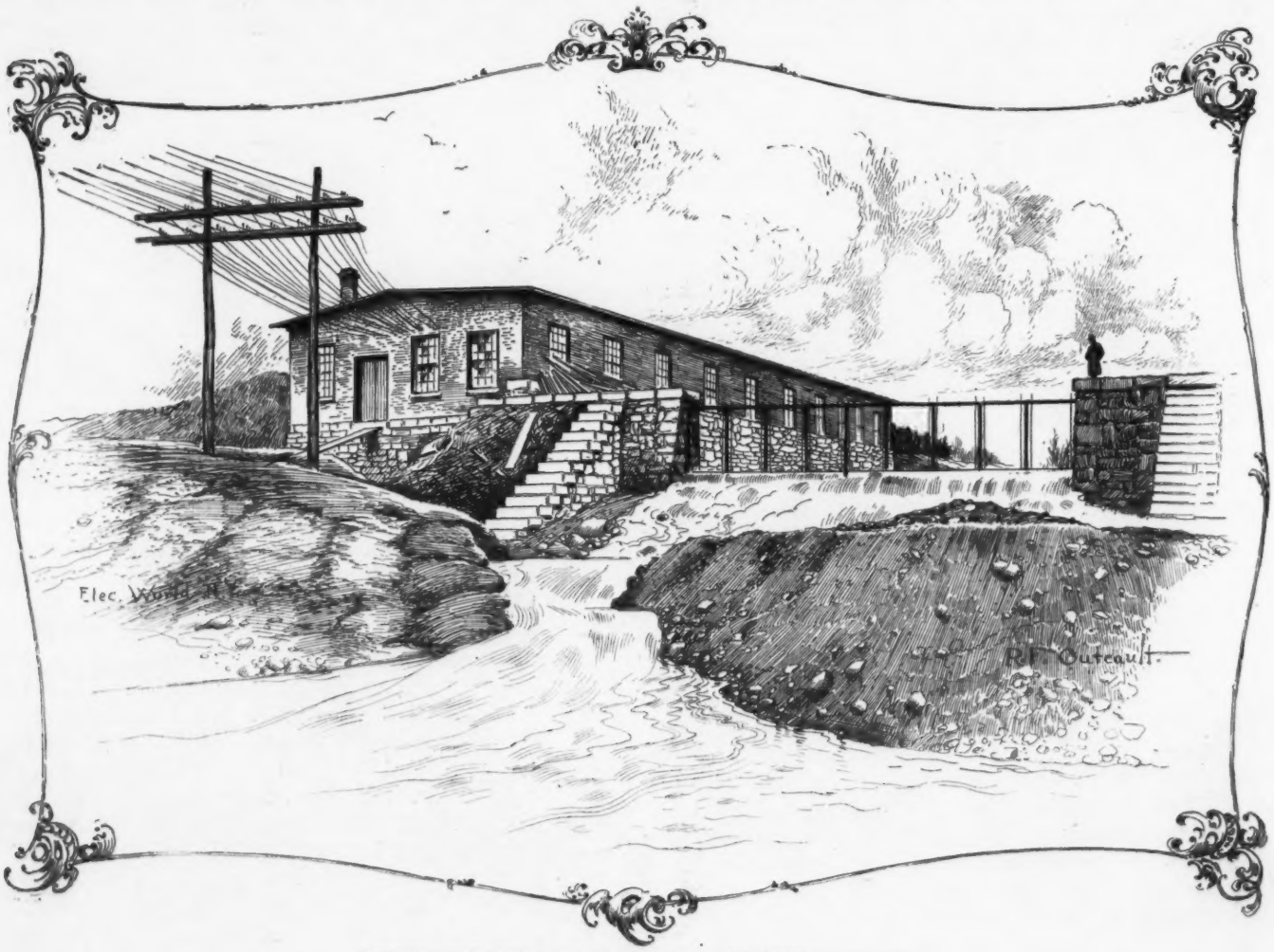
A very lengthy but interesting paper was recently read on matters connected with the electric lighting of the city of London by Major General C. E. Webber. The discussion, though brief, was, like that on Prof. Forbes' recent paper, somewhat heated; it is to be hoped that this warmth is not to be characteristic of all future debates at the Institution of Electrical Engineers. The origin of the rise of temperature was some by-the-way remarks of Major General Webber on the financing of the city lighting. When it is state that a pioneer company was formed in February, 1891, to provide £25,000 for the purpose of carrying out the contract with the city authorities until the public could be induced to subscribe, and was dissolved in the following October, carrying off as a reward for its public spirit a profit of some £50,000, it will be seen that a few remarks on finance matters were not uncalled for. The system on which the city lighting is carried out consists, as no doubt many of your readers are aware, in generating current at 2,000 volts at a station on the south side of the river and transmitting it by concentric rubber insulated cables drawn into wrought iron pipes to a number of transformer sub-stations within the city area, and distributing thence on the three-wire system. The low pressure networks attached to the sub-stations are electrically independent, although the sub-stations themselves are interconnected on the primary side. General Webber gave some valuable information with regard to subways, of which there are several examples in the city, and his experience does not tend to confirm the demands of those municipal enthusiasts who would have huge tunnel light subways constructed, regardless of expense, in every street of the metropolis, and gas, water, telephone, telegraph, electric lighting and pneumatic mains forced into them. Such subways General Webber has found to be of some use for trunk conductors, but out of the question for distributing mains. The system of underground mains generally adopted for distribution purposes within the city has been the three-way, triangular-shaped, steel-sheathed bitumen casing. A careful canvass of the city has elicited the fact that in a first-class block there is about .25 of a light per square yard of ground space, and that from 50 to 75 per cent. of the existing lights may reasonably be expected to be replaced before long by glow lamps. Working on this basis, the total number of 8-c. p. glow lamps that the city company will have to provide for will be 340,000. General Webber gave detailed drawings of the transformer sub-station constructed in the churchyard of St. Bene's Sherehog, in which considerable ingenuity seems to have been displayed in making the maximum use of the minimum space, and in providing against infiltration of water and foul air. One point which may perhaps be of interest on your side of the water is that instead of running their mains straight up the main streets of the city and tapping them at intervals with house connections, the shops abutting on the main streets have been approached as far as possible from the rear, thus avoiding the necessity of constantly opening up the thoroughfare of some of the busiest streets of the world to make house connections. The glass chosen for the lanterns for the street arc lights is stated to be "rippled" glass of .145 inch in thickness, absorbing 21.73 per cent. of the light, this being found considerably less absorbent than opal or ground glass. Of the 900 street glow lamps which it was proposed to run in series, and which were to range from 100 to 200 watts each, only a few have, up to the present, been erected in Basinghall street. General Webber is very half hearted in his support of street glow lamp lighting, but nevertheless put forward a workmanlike design for a street glow lamp, wall bracket and lantern. In the discussion that followed Messrs. Kapp, Esson, Alexander Siemens, R. E. Crompton and Prof. Silvanus Thompson took part. Mr. Kapp was very anxious to discover how the transformers, which are placed in the lowest part of the sub-stations, were going to be kept dry. Mr. Siemens advocated lead-covered, iron-armored cables laid direct in the ground, and thought that the necessity for hollow cored cables where alternating currents were concerned was much exaggerated. Mr. Crompton, as usual, showed that the whole thing could be carried out much better on the low pressure system and by using his various patented contrivances. There was a general consensus of opinion that street glow lamp lighting was not such a hopeless affair as General Webber was inclined to think.

Three-Phased Plant at Concord, N. H.

AS the first to adopt the three-phased system, the plant of the Concord Land and Water Power Company, Concord, N. H., has, perhaps, attracted more attention than any recently installed. Business was commenced by this company about two years ago with a small steam arc lighting plant. A year ago it acquired the gas company's electric plant, and this was soon followed by the addition of all the electric power business of the street railway company, so that it now has the entire electrical field. The company has just completed a large hydraulic and electric plant, located at Sewalls Falls, in the city of Concord, which was the only undeveloped fall on the Merrimac River.

The dam flows the water nearly thirteen miles, and the twenty-two feet of fall obtained gives an average of 5,000 h. p. The dam is a magnificent structure, 22 feet from foundation to crest, 67 feet from the down stream to the up stream face, and is designed to carry safely, in cases of extreme flood, a sheet of water over its entire surface ten feet thick. The normal flow is about two feet. The dam is what is known as a crib structure, and considered the finest of its kind in the country. It was designed by Mr. E. F. Smith, of Philadelphia, and is constructed with timbers placed cob-house fashion, thoroughly bolted together, the interstices being hand packed solid with granite, making a stone dam, held together by the cribwork, instead of cement. Four rows of sheet piling extend from one abutment to the other, and each row is puddled with gravel. The up stream face of the dam is planked and puddled, while a curved steel fender protects the comb of the dam from the attacks of ice or logs. The cribwork is composed of 10-inch by 10-inch and 12-inch by 12-inch timber, the top layers being Georgia pine, covered with 5-inch Georgia pine plank, armored with 3-8-inch steel plates. The water makes five separate falls on the dam structure, and leaves the lower apron with very little momentum, and as a result does not scour. About 1,500,000 feet of timber and 20,000 cubic yards of rubble stone were used in the dam proper, and 5,000 cubic yards of hammered granite were required for the abutments, guard walls and head gates.

The gates are five in number, about 10 inches by 12 inches inches each. The rigging is novel, ball bearings being used, and the friction so reduced that one man can easily operate them. They were designed by Mr. John R. Freeman, of Boston, Mass., who is consulting hydraulic engineer for the company. The water flows through a canal about 1,000 feet long, 75 feet wide and 12 feet deep, to the power house, where it passes through a large rack to the forebay and thence through five 8 1-2-foot penstocks to the wheels.



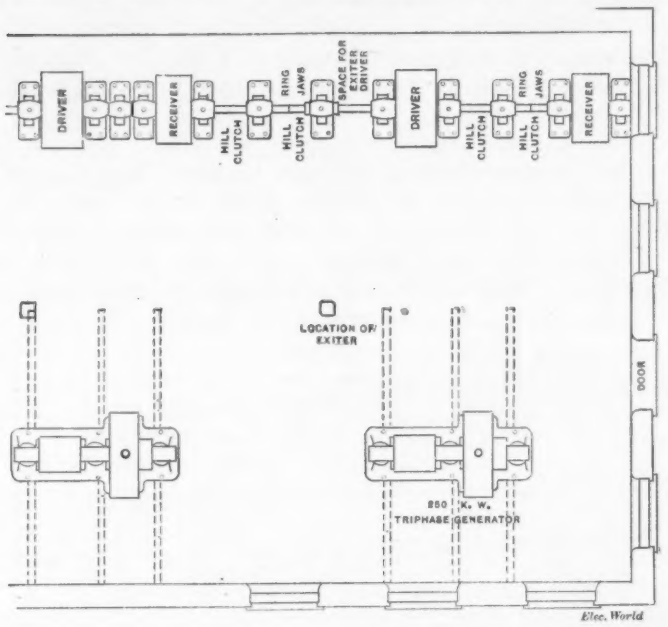
THREE-PHASED PLANT AT CONCORD, N. H.

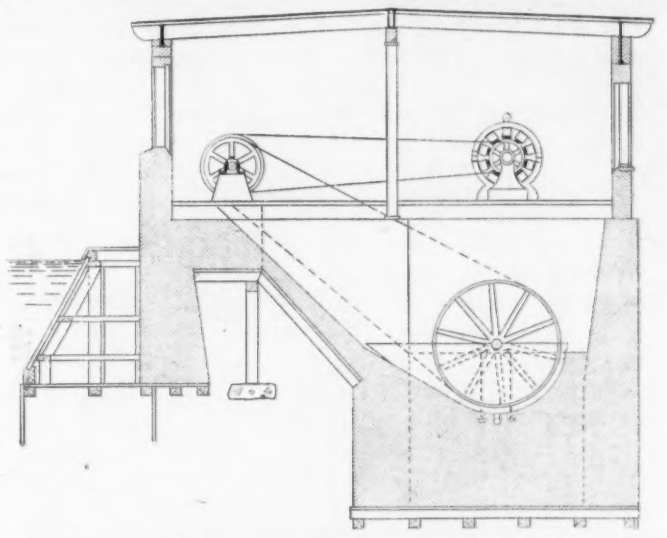
Each penstock supplies a pair of 39-inch Rodney-Hunt turbines, each pair of which gives 400 h. p., making a total of 2,000 h. p. at the power house, leaving 3,000 h. p. available for manufacturers who may desire to locate on the company's land. Horizontal turbines are used, with draft tubes, thus avoiding gears, the power being transmitted from each pair of wheels to the shafting in the generator room by belts. The shafting is arranged with quills and clutches, so that any wheel or section of shaft may be run independently of any other. The pulleys on the shafting and water wheels are very heavy. The idea of using flywheel inertia as a factor in the regulation of water power for electric work is being tried here for the first time, with great success.

The view of the interior of the power house is from a pho-

tograph taken some time ago, and shows but one of the large triphased generators. There are to be six of these, two being in operation at the present time. There are also 70 50-light Thomson-Houston arc generators.

The large generators are of 250 kw. capacity and separately



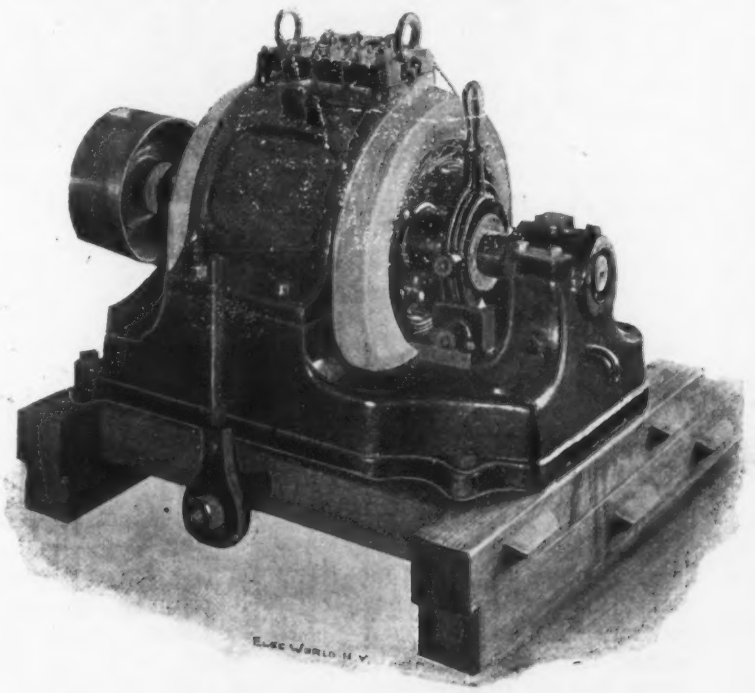


PLAN AND ELEVATION OF CONCORD STATION.

excited. There are ten poles and the ends of the pole pieces are laminated. The speed is 600 revolutions per minute. They are driven by a 36-inch belt, there being a ring oiling bearing on each side of the pulley. The main frame, a single casting weighing nearly eight tons, includes the base and lower half of the field and the bearings. The armature is of the toothed type, and the windings are Y connected, somewhat similar to the Thomson-Houston arc armature. Current is taken from rings by three sets of copper wire brushes 1-2 inch by 2 inches, two brushes to a set. The total weight of the machine is 16 tons. The exciters are 5 kw. 125 volt Edison bipolar machines. These large generators are belted to quills and connected to the shafting by special Hill clutches, the shafting, pulley, etc., being furnished by the Kidder Machine Company of Franklin, N. H. The pulleys are novel, neither key nor set screw being used; the hubs are bored out tapering, and a split sleeve which fits both shaft and taper, forced in by means of bolts, extending through hub, clamps them to the shaft. These pulleys run perfectly true, adjust themselves to slight variations in size of the shaft, do not slip, and may be taken off very readily and quickly. The shaft and quill bearings are all fitted with oiling rings; in fact, every bearing in the power house is self-oiling.

The current is generated at 2,500 volts, and a Weston voltmeter reads direct from the line with a multiplier instead of the usual transformer. Carpenter rheostats are used. The switchboard is of the skeleton type. Acoustic synchronizers are provided for parallel running. Type "F" transformers were specially designed for the frequency, with more iron in the cores and oil as an additional insulation.

As will be seen from the cut, the building is a plain, substantial brick structure, mill construction being followed in its design; every window is double, both sets of sash being hung on cords and balance weights. The roof consists of 3-inch matched plank spiked to rafters, one inch of lime mortar, one-inch pine boards, and on top of all a five-ply tar, felt and gravel roof. No provision has been made for heating, and the building is so constructed that the heat thrown off by the generators, which run continuously, has been found to be sufficient. The wires are led out of the building through porcelain tubes set slanting in the brick walls, and nothing inflammable is used. The first span of the line after leaving the power house is 475 feet, across the river, and this is accomplished in a novel manner; one set of the span poles is shown in the view of the power house. Silicon bronze wire is used on this span, each wire being three feet from any other and the centre sagging 25 feet from the ends of the span. The ends are tied to seven deep groove, double petticoat, glass insulators, placed in a zigzag, four one and three the other side of each wire, on locust pins, with a tie nearly seven feet long. The poles are 40 feet long and 12 inches in diameter at the top, and the arms are made by bolting an 8-inch by 8-inch by 25-foot Georgia pine stick on each side of the pole, with a 6-inch by 10-inch piece placed flatwise between, thus giving room for the pins;



THREE-PHASED MOTOR.

large bolts extending through the pole and arms are guyed to anchors.

The mains in the city are all cross-connected and fused, so that any section may be cut out for repairs, as the current is on continuously. Feeders tap the lines at points of heaviest load. The power and lighting circuits are separate, but are sometimes fed by the same generator.

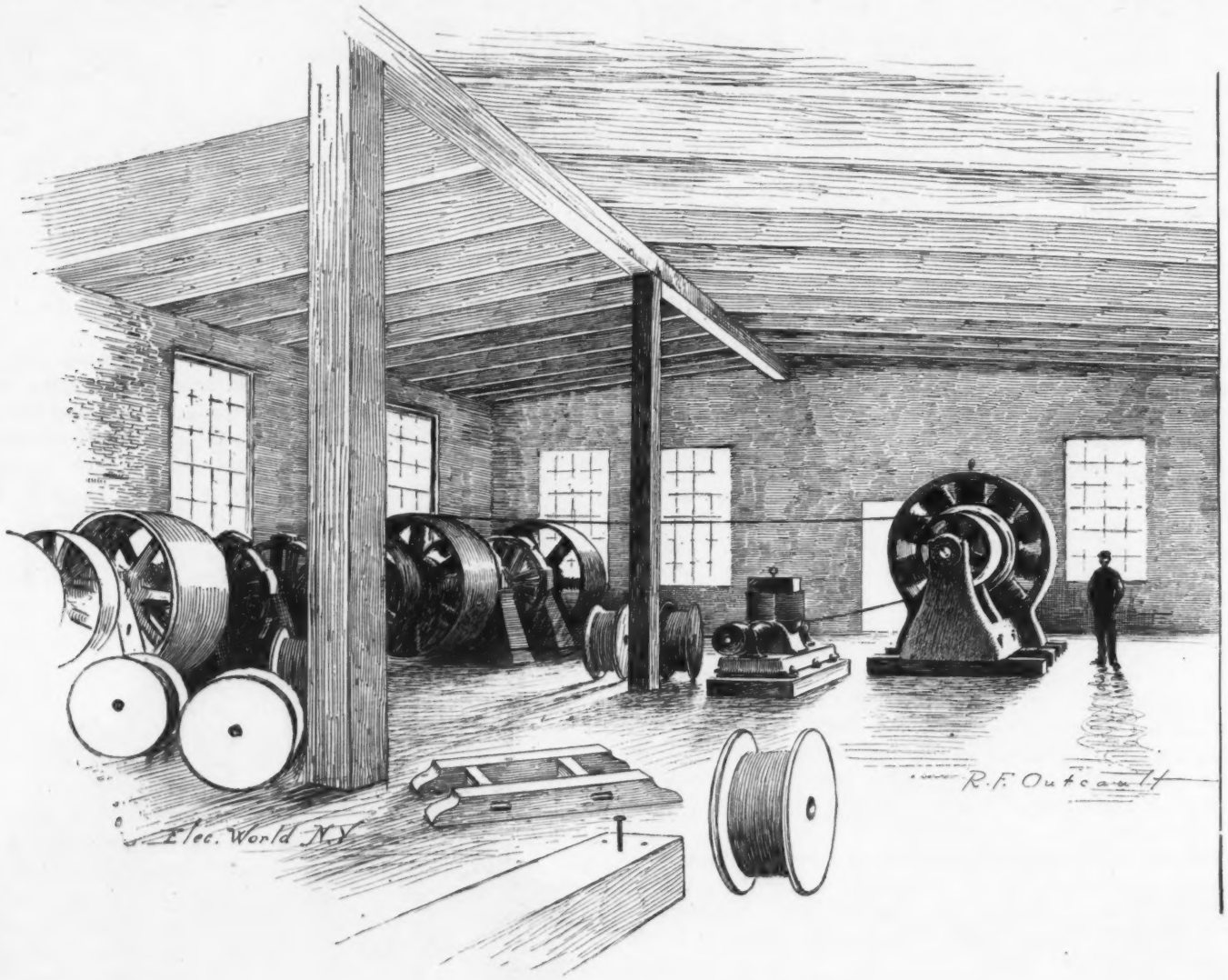
The line runs to the centre of the city, about three miles away, where triphased current of a frequency of 50 is de-

livered to the mains at 2,200 volts pressure. It is transformed to 110 volts and delivered to consumers for arc and incandescent lighting, power, heating and cooking. All current is sold by meter, the rate for lighting being 20 cents and for other uses 10 cents per kw. hour. The company at present supplies nearly 300 arc and 5,000 incandescent lights, 400 h. p. for motors and 30 kw. for heating and cooking apparatus. At the public city cooking school instruction is given exclusively on electric cooking apparatus.

The accompanying illustration shows one of the three-phased motors. The voltage in the primary, or stationary, windings is 110, while that in the secondary, or rotating, 15. The resistance of the secondary, to facilitate starting, is short circuited, when the motor attains speed by a switch in the shaft, operated similarly to a friction clutch, with a small lever. The starting torque is said to be three times the running torque, and the motors start like a direct current shunt machine, with equal commercial efficiency. The apparent and actual watt curves run very close together, except at small loads. The sizes up to 15 h. p. have four poles and run at 1,500 revolutions, while the 20 h. p. and 25 h. p. have six poles and make 1,000 revolutions. The speed is dependent on the speed of the generator, but is not affected by variations in voltage within certain limits. On overloading they do not stop immediately, but gradually slow down as a shunt motor. Mr. E. F. Carpenter, the superintendent of the plant, is authority for the statement that in the case of a 5 h. p. motor driving a dynamo with a load of 9 h. p., the motor current was reversed and in just four seconds by a stop watch the motor was at speed running in the opposite direction, apparently as unruffled as if it was its usual treatment.

The company has just commenced to furnish current for the Western Union Telegraph lines from Nashua to White River Junction, the novel feature being that both positive and negative current is supplied from one machine—an exciter. To do this, four lamps were placed in series across the machine terminals, grounding the wire that connects the two middle lamps, all of which were 32-c. p., 110-volt incandescents. Then by connecting to each machine terminal the telegraph company was able to dispense with a large room full of batteries.

All the electrical apparatus for the plant has been furnished by the General Electric Company. Mr. George F. Page, the organizer and moving spirit in this enterprise, is president of the Page Belting Company, which has furnished all the belting. Mr. H. J. Odell, the popular treasurer of the company, is president of the Franklin Needle Company, and a very able financier. Messrs. Winthrop Coffin, Jr., J. C. R. Peabody, F. W. Prescott, A. A. Glasier, J. E. Fernald, C. T. Page, C. C. Danforth and F. S. Streeter constitute, with the above, the board of directors. The power house mechanical and electrical features of the plant are the design of Mr. Eugene F. Carpenter, electrical engineer, who has been general superintendent of the company since its incorporation. The work of construction at the falls has been carried out under Mr. Daniel Ulrich, of Newark, N. J., engineer in charge of the work. The first earth was moved on Aug. 1, 1892 and the machinery was put in motion the first time Feb. 28, 1894, the young son of the superintendent turning the gate. The machinery was put to work at once without the usual nursing process, and the first hot bearing has yet to make its appearance.



INTERIOR OF CONCORD STATION.

Practical Properties of Polyphase Apparatus.—II.*

BY LOUIS BELL.

THIS method of compounding polyphase generators seems to promise ready applicability to the largest machines and very close automatic regulation of the voltage. The arrangement may be varied, but the underlying principle must remain the same—the automatic variation of voltage on the polyphase end of a rotary converter in response to the varying output of the generator by means of varying inductances obtained from coils in the main circuit, and acting either directly or reversely to govern voltage applied to the rotary converter. In practice, the method works quite satisfactorily and effectively. It permits of very close regulation of the voltage for all loads at the machine, or of over-compounding at the distant end of the line, and that even with severely inductive loads. I have tried a number of experiments to determine the best working conditions of this method of compounding, and the results are most striking.

A record of experiments made after this paper was written is illustrated in Fig. 2. The generator was first run with a non-inductive load at 114 volts initial. The output was driven up to 26 1-2 kilowatts and the voltage at the end was 116.0 (*A*). It had varied slightly in the earlier portion of the curve, the extreme variation from the initial voltage being a couple of volts. That was with a poor machine, and lacked the good results that could have been obtained had the compounding arrangement had less work to do. Now we tried the same machine under inductive load (*B*). The initial voltage was again 114 and it was arranged to over compound, so that at 30 kw. we got 148 volts. The device over compounds just as handily as it compounds for uniform voltage, and, furthermore, I may say, that by proper

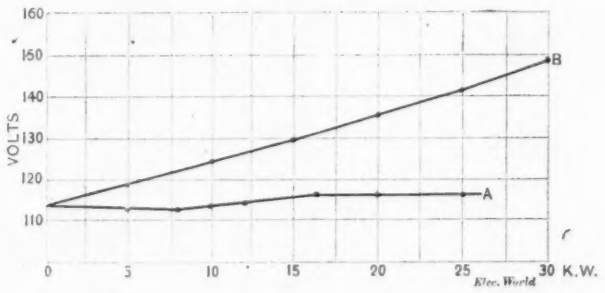


FIG. 2.

adjustment of the inductive coils and the rotary converter, it is possible to make the machine compound closely or over compound, either for inductive load or non-inductive load, or for a load which is varying, sometimes non-inductive and sometimes inductive. The very act of the shifting of the phase due to running with an inductive load may be made to help the rotary converter overcome the lagging current, as was the case in the example I have just given, where the voltage rose somewhat like 25 volts on a heavy load consisting of induction motors running very light.

All this matter of regulation is of particular moment in installations intended mainly for power purposes where the variations in load are apt to be considerable. Where, however, these variations are extreme I do not believe that any automatic apparatus can altogether obviate the necessity of watchful and intelligent hand regulation, especially when water wheels are the prime movers. It should be remembered, however, that the variations in voltage which pass altogether unnoticed in ordinary service and are practically of little account are much greater than would be at first sight supposed. An evening passed in any station operated by water power teaches a useful lesson in this respect. Quite considerable occasional variations, particularly if slow, are far less objectionable than repeated or periodic ones of much less magnitude, such as are produced by "hunting" in a governor or overmuch fussing with the regulating devices. A governor should be "dead beat" even if something of sensitiveness is sacrificed to that end.

Polyphase, like other alternating current generators, make good synchronous motors. In fact, they are decidedly better than others for this purpose, in that they are self-starting with more or less facility, and do not go out of step quite so easily as the single phase machines. They are, as it were, more flexible. They start really as induction motors; that is, they may properly be regarded as induction motors having a revolving primary element and a non-laminated fixed secondary without windings, exerting torque simply by virtue of induced currents in the pole pieces.

Naturally they cannot start very efficiently under these conditions and for motor purposes it is much better somewhat to modify the structure, so as to provide secondary windings or other devices to approximate the effect of a genuine induction motor. Nothing very complicated in this line is necessary, and it is quite easy to produce a synchronous motor that will be self-starting even with a considerable load of shafting. In the Redlands triphase plant, for example, the motor of 150 h. p. is belted to a short countershaft mounted in a timber frame and carrying two large pulleys. The smaller of these drives by a 36-inch belt a wooden wheel 18 feet in diameter mounted on a crank shaft that drives two large ammonia compressors. A pulley on this shaft is belted back to the framework aforementioned, and drives a force pump for the ice making machinery, a circulating pump for the water jackets of the compressors, and a small ice elevator. All this machinery is brought promptly up to synchronism by the motor without the intervention of clutches. The starting torque is thus quite sufficient for most ordinary uses to which a large motor is likely to be put.

The synchronous type of polyphase motor is especially adapted to large units. Being a non-laminated structure, it is easier to build and somewhat cheaper than an induction motor of the same size would be, and furthermore it possesses the advantage of introducing no lagging current whatever into the line, except at the moment of starting. While this lagging current is not of great moment on ordinary lines, it may as well be avoided where by so doing a machine equally as good and cheap can be obtained without any additional complications. With large units, too, there is generally less need of a very great starting torque, and consequently induction motors are far less necessary in the large sizes than in the smaller ones. There is no practical difficulty whatever in building or operating these large synchronous self-starting motors, and they are likely to come into extensive use.

INDUCTION MOTORS.

Perhaps the most striking characteristic of the polyphase system is the use of the polyphase induction motor, obviating, as it does, necessity for moving contacts and enabling the ready employment of forms of winding which give remarkable immunity from the ills to which continuous current motors are heir. In all that has been said about these motors there has been an unfortunate absence of exact data, particularly as regards their ability to start under heavy loads, the current required at starting, the current required when running light, the lag factors, light and loaded, the variations of speed under varying load, and other charac-

*Abstract of a paper read at the eighty-third meeting of the American Institute of Electrical Engineers, Jan. 17, 1894.

teristics which are of direct practical importance in the use of such apparatus.

The induction motor consists essentially of two laminated structures, one fixed and the other revolving, and each wound symmetrically for phases more or less in number, according to the system on which the machine is to be employed. It may be considered as a transformer with its magnetic circuit imperfectly closed, and of which one member is free to revolve. For mechanical reasons I think it is generally preferable that the primary element which receives the higher voltage should be fixed, and the low voltage, secondary element, movable. By this arrangement, too, all necessity for moving contacts is avoided. For certain specific purposes the reverse of this plan may now and then be advisable.

As to the general properties of these machines, I can hardly sum them up better than to say that they behave in a manner strikingly like well designed shunt wound continuous current motors, having, however, the advantage of being simpler and of having no commutator. Even their efficiency is closely similar to that of continuous current motors of the same size both as regards its maximum value and its value under moderate loads. The hysteretic losses and those due to parasitic curents are, however, a source of inefficiency that has to be carefully considered in order to reach a satisfactory result.

These losses are located in large measure in the primary element of the motor, and would apparently indicate the desirability of making this the revolving, and naturally smaller, part of the machine. The advantage, however, of using a very simple and substantial winding on the revolving element is too great to forego for the sake of a little saving in hysteresis.

Induction motors can be made to start readily under load, yielding, when properly designed for the purpose, a starting torque up to four or five times the full load running torque. Even more than this can be obtained if it be needed, but for most practical purposes running torque is quite sufficient, and it is perhaps best generally not to design motors with abnormal starting powers in view, regarding such rather as special types. As in continuous current work, a motor fitted for unusually heavy strains is not necessarily the best all around machine.

For everything except extraordinary requirements such as may be sometimes met in hoisting, a uniform design and rating may be conveniently kept, as it is very easy to regulate the torque and the current required to produce it within wide limits by varying the resistance included at starting in the secondary circuit. I know of no motors without such a starting resistance that are capable of giving any considerable starting torque without an enormous initial rush of current, and even were one designed to secure a good torque without armature resistance, it would be almost certain to exhibit various other undesirable qualities that would more than offset the advantage.

The office of the starting resistance is two fold: First, it limits the possible current in the armature so that it will not beat back the induction from the field; that is, it sets a limit on the armature reaction. Second, it limits also the lagging in phase of the armature behind the field. There is a particular resistance best suited to each case, for which the torque is a maximum, at the given voltage. Any variation from this value will diminish the torque, the current meanwhile rising or falling according as the resistance is diminished or increased. This critical resistance should be found and used whenever it is necessary to start under abnormal loads. At a certain second value of the armature resistance the torque per ampere will be a maximum, and this determines the best resistance to be used for cases where a large static torque is not necessary. Somewhere between these points will be found the best working resistance for practical purposes. The first point named does not call for impracticable current, nor the latter for inconvenient torque if the motors be properly designed.

In using a starting resistance I prefer to fix it within the armature spider and so to avoid all need of collecting rings. Save for this device, moving contacts of some sort must be used either to lead the primary current into the revolving element or to connect the resistance to the secondary, either of which procedures is objectionable, particularly the latter.

There is no subject connected with polyphase work which has been the theme of more hasty conclusions and ill-advised criticism than the current required by polyphase motors in starting. The popular verdict pronounces it enormous, an opinion generally derived from hearsay or from experiments with poorly designed motors, often with armatures of the squirrel cage type, than which nothing is more ineffective in starting, if the motor be decent in other respects.

Nothing can be more grossly exaggerated than this common idea of immense starting currents. The best way to refute it permanently is to give exact experimental figures. The annexed curves (Fig. 3) will show very plainly the facts

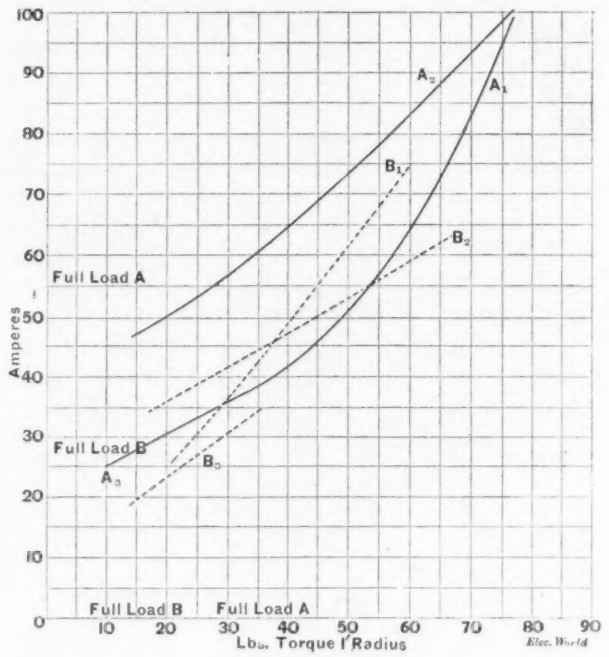


FIG. 3.

in the case. The torques given are genuinely static, being obtained by fitting a horizontal brake beam to the shaft of the motor and resting a stud on the beam upon a platform scale. The resistances used were of manganin strip. The currents were obtained from a current indicator standardized from a Siemens dynamometer, and the readings were made after the pointer had come to rest, a precaution very necessary, as the instrument was not at all dead beat. The current thus obtained is a true maximum for the given torque, the armature being permanently clamped at rest.

In Fig. 3 the relation between starting torque and current is very clearly shown, as well as the importance of the starting resistance. In the figure the curve $A_1 A_2 A_3$ belong to a 10-h. p. triphase induction motor, and $B_1 B_2 B_3$ to a similar machine of 5-h. p.

A_1 shows the effect of varying the resistance in the secondary on the relations between starting torque and current, the voltage being kept normal and constant. A_2 shows the variation of torque with current for a given fixed resistance, the voltage being varied, and the resistance being such as to give heavy torque. A_3 is the same as A_2, e

cept that the resistance was such as to give very moderate starting currents. Full load torque was 35 pounds.

B_1, B_2, B_3 are similar curves from a 5-h. p. triphase motor, the full load torque being 17.5 pounds. Now examine the curves. Instead of abnormal currents being required in starting, each of the motors under examination will develop full running torque on considerably less than full load current. At full load current, in fact, each of them gives some 50 per cent. more than running torque. And this condition of things is not in the least exceptional—it will be true of any properly designed motor, unless it be intentionally adjusted to have a very great starting effort at normal voltage, as shown in Fig. 4, which is a curve from a 10-h. p. motor. Here curve *A* shows the relation between current and torque with a carefully adjusted resistance, and curve *B* the same relation without armature resistance. In this latter case we have reproduced just the state of affairs that is encountered when one attempts to start an induction motor by a rheostat in the primary circuit. A comparison of *A* and *B* tells its own story as to the advisability of this procedure. The results are never comparable with those obtained with a resistance in the secondary under similar conditions. It may be well here to note that an ohmic resistance cannot be replaced by an inductive resistance for the purpose under consideration, as the armature

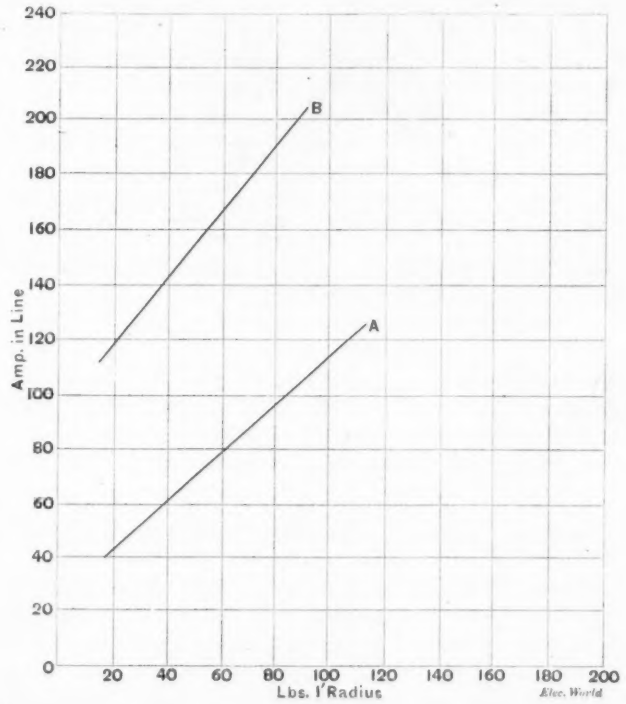


FIG. 4.

current is thrown thereby so much out of phase that no even tolerable results can be obtained. In leaving the subject, I need only say that there is no particular difficulty in constructing a polyphase motor that will give any torque that can reasonably be asked, and with a starting current by no means disproportionate to the result obtained.

The next thing that comes up for consideration is the power factor which may be expected in polyphase motors. By the power factor we mean the ratio between real and apparent watts which measures the angle of lag introduced by the motor. It goes without saying that a high power factor is desirable both on the ground of requiring less current capacity in the lines and generators and on account of less inductance in the circuit, and consequently less trouble in keeping up the proper voltage. In motors of various designs the power factor is probably the point in which there is the greatest and most serious variation.

Fig. 5 gives three curves showing the variation of power factor with load in three typical three phase motors. Curve *A* is the power factor of a 15-h. p. four-pole motor designed to run at 50 cycles. Curve *B* is from a 5-h. p. motor of closely similar design. Curve *C* is from another 5-h. p. motors it is 75 per cent., and in the other 79 per cent.

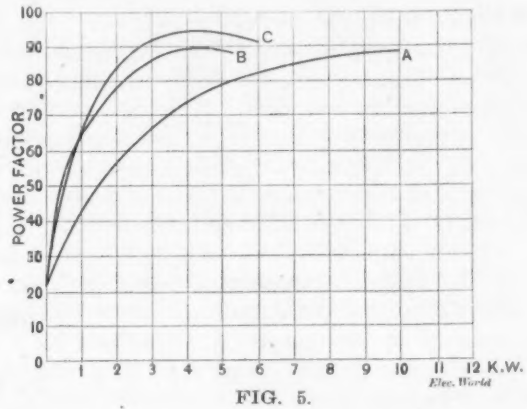


FIG. 5.

matter of power factor. The last curve shows what may be accomplished by designing with special care for a high value of power factor.

Now the points to be noticed in these curves are the following:

First. That in all three motors at and near full load the power factor is closely in the vicinity of 90 per cent.—in curve *C* fully 94 per cent.

Second. The power factor even at half load is still good. In the 15-h. p. motor it is 84 per cent.; in one of the 5-h. p. motors it is 75 per cent; and in the other 79 per cent. In fact, the half load values for the power factor, as here shown, are greater than the full load power factors of European three phase motors which have been described up to date. The Dobrowolsky 5-h. p. three phase motor* has a full load power factor of but .68, while the power factor of a small Oerlikon motor (as described by Mr. Kapp from actual tests) is but 74 per cent. at full load. We must not, however, attach too much practical importance to very high power factors, for the reason that those shown in Fig. 5 are already within the range of first-class commercial work. Perhaps we may better investigate the relation of this power factor in actual operation by reference to Fig. 6, which shows the relative currents required at different loads by three sizes of three phase motors. Curve *A* is for a 5-h. p. motor, curve *B* for a 10-h. p., and curve *C* for a 15-h. p. For convenience we will call the ordinates total amperes required.

Suppose now we have a dynamo running an exclusively

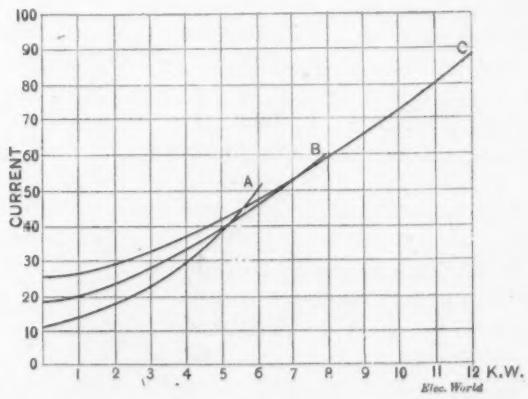


FIG 6.

motor load composed of these three sizes of machines, and let us see what will be the actual conditions when the motors

*The Electrical World, April 22, 1893

are running fully and partly loaded. Let us suppose the load to consist of ten 15-h. p., ten 10-h. p. and twenty 5-h. p. motors running at full load. The current demanded (as by the curves on Fig. 6 for this combination) is 1,950 amperes, and the average lag factor will be at least 88 per cent., which could readily be raised to 90 per cent. if it were desirable to pay special attention to that feature of design.

At half load the aggregate current required would be 1,125 amperes—57 per cent. of the full load amperes—and the average power factor 81 per cent. Even at one-third load the condition of things is by no means as serious as it might be, inasmuch as the aggregate current is 890 amperes—45 per cent. of the full load amperes—and the power factor is still 72 per cent. The generator can readily take care of any of these loads without serious trouble from the lag introduced on the line, and even supposing that the total generator capacity be taken at 200 h. p. instead of 350, the aggregate capacity of the motors, it would still be able to operate all the motors at half or one-third load without unreasonable over-excitation on account of the lagging current, as may readily be perceived by reference to figures for excitation and the lagging current which I have previously given.

Of course it is possible to reduce the lag factor perceptibly by the employment of condensers, but it is certainly an open question whether so long as it is practicable to obtain power factors in the vicinity of 90 per cent., and even above it, without using condensers, the extra gain is worth the extra complication. There will certainly be some value of the power factor which it will not pay to increase by adding condensers—just what value it is hard to predict until condensers have come into more general use. Even if condensers be used, they will not necessarily bring up the power factors, at moderate loads, to any very startling figures.

(To be continued.)

How Shall We Operate an Electric Railway Extending 100 Miles from the Power Station?

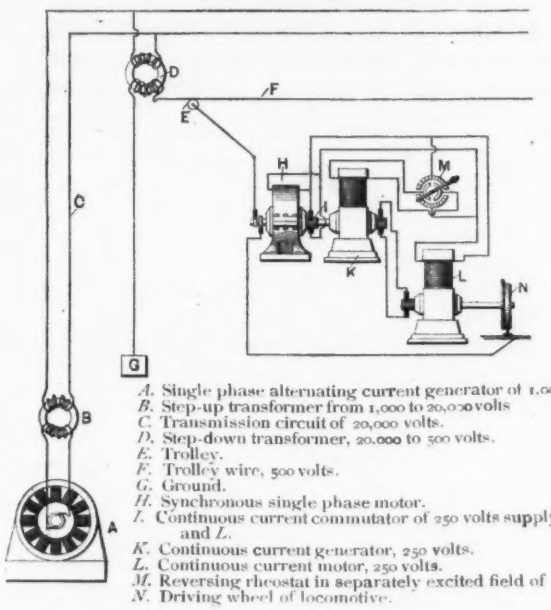
In a paper presented at the last meeting of the American Institute of Electrical Engineers Mr. H. Ward Leonard considered the question of operating an electric railway 100 miles from the power station. The assumption was made that there exists a very economical source of power, possibly a water power, so situated that the length of railway to be operated in either direction is 100 miles.

The following features seem desirable, if not essential, in such a railway: 1. A single trolley contact shall be used for supplying current to the locomotive. 2. The E. M. F. upon the trolley shall not exceed 500 volts. 3. There shall be no apparatus in motion and requiring attention between the power station and the locomotive. 4. No commutator, rheostat or controlling device on the locomotive shall be subjected to a higher E. M. F. than 250 volts, and there shall be no sparking on any of the apparatus under any normal conditions. 5. The entire control of the locomotive in either direction shall be effected by the movement of one lever. 6. The load shall be started from dead rest by an amount of energy taken from the source of supply which shall not exceed one-quarter of the energy required to operate at full speed on the level. 7. The retardation of the load in coming down grades, and in stopping, shall be effected by converting the motors into generators, which shall feed back current to the line, and thereby assist the power station in operating other locomotives. 8. The motors must be reversible when operating at full speed, without damage to the motors or other apparatus. 9. The efficiency of the system from power on the generator shaft to the drawbar pull of the locomotive shall be at least 50 per cent. 10. The locomotive shall produce at least 500 h. p. when operating at a speed of 80 miles per hour.

For such great distances, in order to operate with a loss in conductors of 20 per cent., the initial E. M. F. must be 20,000 volts, in order to make the cost of copper $20 per kw., which is about the best figure for cost of copper under the conditions. The alternating current must evidently be used, and as there is but one trolley contact, it must be single phased.

The system proposed, which is diagrammatically shown in the accompanying illustration, is briefly as follows:

Starting with standard 1,000-volt, single-phased alternators in the power station, the potential is raised to 20,000 volts by step-up transformers. At suitable points, say every two miles, the potential is transformed down to 500 volts. Now, with this current, a synchronous alternating motor can be operated, but cannot be regulated in speed, reversed, or started under load. It is evident that some form of gearing between the synchronous motor and the axle will solve the problem. Let the synchronous motor drive a



A. Single phase alternating current generator of 1,000 volts.
B. Step-up transformer from 1,000 to 20,000 volts
C. Transmission circuit of 20,000 volts.
D. Step-down transformer, 20,000 to 500 volts.
E. Trolley.
F. Trolley wire, 500 volts.
G. Ground.
H. Synchronous single phase motor.
I. Continuous current commutator of 250 volts supplying fields of *H*, *K* and *L*.
K. Continuous current generator, 250 volts.
L. Continuous current motor, 250 volts.
M. Reversing rheostat in separately excited field of *K*.
N. Driving wheel of locomotive.

OPERATION OF LONG DISTANCE ELECTRIC RAILWAYS.

direct current generator and use the current thus generated to supply the motors connected with the axles of the locomotives. This portion of the system is the same as the well-known Leonard system, as applied to elevators. Regulation is secured by varying the field of the generator supplying the motors and by weakening, strengthening or reversing the field of this machine any desired speed or direction can be obtained. The continuous current generator should have its field separately excited. The propelling motors can be series, shunt or separately excited, but the best results will be obtained by separate excitation. To secure exciting current for the alternating motor and the fields of the continuous current generator and motor, it will be best to drive by means of the alternating motor armature, and if desired in the same field, a continuous current winding connected to a commutator, from which will be led the current for exciting the fields of all three machines. The fields should be wound for 250 volts, and this same voltage used for the continuous current armatures.

Suppose now the locomotive to be at rest. The synchronous motor is running and driving the generator armature at full speed in a field of no intensity; hence the propelling motors receive no current. The first contact upon the rheostat in the generator field circuit is now made, and let the resistance in the rheostat be such as to produce say 25 volts

at the generator brushes. This 25 volts will supply a very large current to the motor armature at rest in its saturated field, and consequently will produce a sufficient torque to start the entire load and continue to move it at a slow speed. There is now being used 25 volts and say 2,500 amperes in this circuit; this means 62,500 watts, and disregarding transformation losses for simplicity, this means a current of 125 amperes from the trolley. When operating at the rate of 500 h. p. at full speed there will be needed say 1,800 amperes and 250 volts in our propelling circuit, which is 450 kw., and means roughly 900 amperes from the trolley. It is evident, therefore, that the load can be started with but a small fraction of the energy required for operation at full speed, and that there will be no danger of throwing the alternator out of step by applying but one-sixth of its full load.

If operating at full speed, and it is desired to bring the locomotive to rest, the strength of the generator field is rapidly reduced by manipulating the rheostat in its field circuit, so as to reduce to zero the current exciting this field; the E. M. F. produced by the generator then rapidly falls below the counter E. M. F. of the motors, which are being driven in a constant field by the momentum of the moving load, and the motors consequently become generators and supply current to the former generator, which now becomes a motor, and driving the alternator, feeds current back through the trolley, thereby not only bringing the locomotive smoothly and rapidly to rest, but saving the energy usually wasted upon the brake shoes.

Under this arrangement, if steam engines are used as the source of power, the engines are not subjected to the violent fluctuations ordinarily met with in electric railways, and the capacity of the engines, generators and conductors can be much reduced over usual requirements.

Concerning a Change of Policy in the Administration of the Patent Office.*

BY PHILIP MAURO.

The views presented by the author are called forth by the announcement of a rumor that the present Commissioner of Patents had decided to inaugurate a change of policy in his office in the treatment of applications for patents where the margin of novelty is small or the exercise of invention doubtful. The old rule, unwritten, but tacitly recognized, has been when substantial doubt exists to give the applicant the benefit, and it is this rule which it has been said is to be reversed.

The particular point of inquiry is whether the examining corps of the Patent Office has been so lavish, lax and imprudent in the issue of patents, particularly where the novel improvement said to be patentable was of doubtful character, that the public interests have been detrimentally affected, and, if so, what are the particular evils that have resulted from this undue liberality and how far should the Patent Office shift its ground in either direction in order to avoid this? It is the author's belief that there is no ground whatever for the apprehension of damage to the public or to individuals by reason of undue liberality on the part of the patent examiners, and that the work of the bureaus, as a whole, has been characterized by fairness, just discrimination and due appreciation of the rights of inventors, with perhaps a leaning rather in the direction of the illiberality which of recent years has emanated from the bench. The only basis, the author states, for any opinion in regard to laxity in the Patent Office has been that many patents have been held void or illegal by the courts deciding that the subject matter was not patentable or did not rise to the dignity of invention or involve the exercise of mechanical skill. Mr. Mauro holds that, without depreciating the qualifications of the judges, the patent examiners, as a rule, are better qualified to pass upon the patentability of inventions than Federal judges; that the question is one of fact, and a decision that a particular mechanical expedient or departure does not involve invention can have little or no effect or value beyond settling the question in that particular case, and therefore does not involve questions of law beyond expounding the meaning of the statute or declaring legal principles, as to which the voice of the court is the only authority that can be recognized. In the case of most of the patents which have been found void by the courts, new evidence, not accessible to or overlooked by the examiners, has been presented; so that in but a small number of cases can it be said that the decision of the latter has been reversed by the courts. The conclusion, therefore, is that decisions of this kind constitute no reflection upon the work or the judgment of the Patent Office, and no justification for any change of policy in the direction indicated.

The effect of illiberality would be to prematurely stifle and suppress what might be productive of benefit, and thus work injustice to meritorious inventors and at the same time injure the public by depriving them of the advantage accruing from the granting of a patent for the use of a novelty, however trivial, for it is by the accumulation of small changes that the industrial arts advance.

The vague nature of the term "inventive faculty" is referred to and the danger pointed out in requiring examiners to rigidly apply this test to inventions. It is argued that patents should be granted for what appear on the face even trivial inventions, as otherwise they would bury in the Patent Office what might be nurtured into something useful to mankind; and there is every ground for assurance that if the inventor succeeds commercially the courts will be ready enough to take away his patent if his invention has not the magnitude thought necessary.

The tendency to trim down each patent to its narrowest dimensions is severely condemned. The grant of a patent to an applicant for more or other than he can sustain before the courts profits him nothing and deprives the community of no right. On the contrary, the failure of any inventor to secure a grant to the full extent of his right is occasion for profound concern. If by the exercise of unusual watchfulness and careful scrutiny the issuing of a few hundred worthless patents may be prevented, the result is creditable to the administration, but can hardly be regarded with satisfaction as to the practical benefit accomplished. The discovery and remedy of a single case of injustice would seem to be a far better basis for a claim upon public gratitude.

The author argues that the duty of the Patent Office under the law is to investigate and decide the novelty and utility of claims, and not to decide whether the inventive faculty has been exercised or not, and regrets the tendency developed quite recently in the latter direction. A tribute is paid to the Patent Office for the great service rendered to inventors through its elaborate investigations, to the end that they may not expend money and time in claiming things really old or really patented. The object and merit of the examining system is that it apprises inventors of the state of the art, and thus prevents them, not from imposing on the public, but from deluding and injuring themselves. If with the results of the examiners' researches before him and with but a slender margin of novelty remaining, the inventor risks the unfavorable judgment of the courts and is willing to pay a fee for a patent of doubtful value, the author can conceive of no possible reason why the Commissioner of Patents should interpose objections. The time consumed in searching for and studying decisions which serve only to cloud a subject already hopelessly obscure could more profitably be employed in those searches for novelty for which the office was created, and for which, out of the pockets of inventors, the Commissioner and examiners are paid.

*Abstract of a paper read at the 84th meeting of the American Institute of Electrical Engineers, Feb. 21, 1894.

THE ELECTRICAL WORLD'S DIGEST OF CURRENT TECHNICAL AND ELECTRICAL LITERATURE

COMPILED FROM THE PRINCIPAL FOREIGN ELECTRICAL JOURNALS. BY CARL HERING.

ELECTRO-PHYSICS.

Dielectrine.—A description of several pieces of apparatus made with this insulating material (see Digest March 3), which is made of a mixture of sulphur and paraffine, is given in "La Lum. Elec.," Feb. 10. An electrophore, 8 inches in diameter and 1 inch thick, gave a spark of over 3-4 inch, and when once charged retained its charge for a long time; the material can be readily worked and polished, and even admits of having screw threads cut into it.

Conversion of Light into Sound.—The "Zeit. fuer. Elek.," Feb. 1, mentions a patent for an apparatus resembling the Bell radiophone, in which an intermittent beam of light, focussed on a glass vessel containing lampblack, produces audible notes; Mercadier has attempted to use this apparatus for a multiple telegraph system.

Thermo-electric Diagram for Pure Metals.—A paper by Mr. Steele is published in the "Phil. Mag." for February; he claims that the results published by Prof. Tait, which have been accepted as the most reliable, are not quite correct; a diagram of the connections and the results of the tests are given.

Propagation of Electricity.—The January number of the "Bul. de la Soc. Int. des Elecs." mention an Academy paper by Mr. Poincare, in which he starts with the so-called telegraphic equation between the self-induction, the resistance and the capacity and deduces mathematically the form and the velocity of the perturbation.

Velocity of Propagation of an Electric Perturbation.—An abstract of Mr. Blondlot's paper is given in the Foreign Abstracts of the Institution of Civil Engineers.

Spread of Propagation of an Electric Disturbance.—The paper by Mr. Blondlot, mentioned in the Digest some time ago, is abstracted briefly in the Lond. "Elec. Rev.," Feb. 23, the illustration being also given.

Reflection of Electric Waves.—An illustrated communication by Messrs. Birkeland and Sarasin is given in the "Phil. Mag." for February.

Calculation of Electromagnetic Forces.—"La Lum. Elec.," Feb. 10, reprints an abstract of a paper by Mr. Vaschy, in which he shows how the expressions in his former paper can be simplified considerably by the introduction of two fundamental relations.

Theory of Electromagnetic Phenomena.—Mr. Vaschy's mathematical paper, in which he gives a method of explaining electric phenomena independently of any hypotheses, is published in full in the January number of the "Bul. de la Soc. Int. des Elecs."

Similarity Between Electric and Magnetic Fields.—"L'Elec.," Feb. 17, reprints a Physical Society paper by Mr. Curie on this subject.

A Fundamental Formula for Magnetic Induction.—The "Elek. Anz.," Feb. 15, reprints an article by Mr. Schwartze on this subject.

Photographing the Spectrum of Lightning.—The Lond. "Elec. Rev.," Feb. 23, describes briefly a method of Mr. Meyer in "Wied. Ann.," volume 5, page 416, in which he uses a diffraction grating instead of a spectroscope; the method has been used with some success.

Capacity of Condensers for Alternating Currents.—The Lond. "Elec.," Feb. 23, abstracts briefly the article by Dr. Sahulka, mentioned in the Digest Jan. 20.

Electromagnetic Properties of Parallel Conductors.—An article by Mr. Steinmetz is abstracted in the Foreign Abstracts of the Institution of Civil Engineers.

Electricity of Drops.—The Lond. "Elec.," Feb. 23, abstracts very briefly a paper of Prof. J. J. Thomson on this subject.

MAGNETISM.

Magnetic Field in a Cylindrical Coil.—Prof. Minchin's Physical Society paper on the calculation of the magnetic field of a current running in a cylindrical coil is published in the "Phil. Mag." for February.

Magnetization by Very Small Forces.—The Lond. "Elec. Eng.," Feb. 23, abstracts briefly a paper of Mr. Culmann in the "Elek. Zeit.," and mentioned some time ago in the Digest.

UNITS, MEASUREMENTS AND INSTRUMENTS.

Resistance Box for High Voltage Currents.—An illustrated description is given in the "Elek. Zeit.," Feb. 15, of the Edelmann resistance box; it consists of 10 coils of 10 ohms (?) each, and is intended for alternating currents of 3,000 volts; the coils are, as usual, connected in series and end in a row of contact blocks, which may be connected to a bar by means of a pair of plugs connected together by a rubber covered, flexible wire; two pair of plugs are used, so as to avoid opening the circuit when changes are made.

Curved Scale of Galvanometers.—The "Elek. Zeit.," Feb. 22, gives an illustrated description of a scale for a reflecting galvanometer made of celluloid and carried in a frame which enables it to be bent to the arc of a circle of any desired radius, the correction due to the use of a flat scale is then no longer necessary.

Influence Machine.—According to "La Lum. Elec.," Feb. 17, Dr. D'Arsonval described before the International Society the improvements of Mr. Bonetti, consisting in abolishing the sectors and in the addition of two new brushes; tests of two machines showed that the output is increased from three to four times and the reversing of polarity is not to be feared; it then becomes necessary to charge the machine, but this is easily done by placing the finger at any point near the circumference of one of the external plates; it is also easily reversed by a similar process. He states that Mr. Wimshurst has now adopted these improvements in his machine.

A New Form of Induction Balance.—The "Jour. of Inst. Elec. Engs." for February contains the abstract of a paper by Mr. Wien; the arrangement consists of a Wheatstone bridge, two arms of which are coils having self-induction and the other two inductionless resistance; a piece of metal brought near one of the coils disturbs the balance, which is restored by the adjustment of a secondary coil inside the

other coil, the time constant of the metal piece being equal to that of the compensating secondary coil.

Induction Apparatus.—In the "Elec. Tech.," Feb. 15, Dr. Krieg gives an illustrated description of a simple method of constructing induction coils.

Potentiometer for Alternating Currents.—Mr. Swinburne's method, mentioned in the Digest Jan. 6, is described in the "Phil. Mag." for February; two cuts are given.

Instruments for Measuring Resistance.—In their serial in the Lond. "Elec. Eng.," Feb. 23, Messrs. Niblett and Ewing describe briefly the Wheatstone bridge with earth return.

Testing the Magnetic Qualities of Iron.—The Lond. "Elec. Eng.," Feb. 23, reprints an Institution paper by Dr. Kapp, in which he describes a practical apparatus for testing iron in dynamos and transformers. A cut is referred to, but not given, and we will defer making the abstract, as the cut may be published in some of the other journals next week.

The Mance Method for Determining the Internal Resistance of Accumulators.—In "La Lum. Elec.," Feb. 17, Mr. Perrin gives a mathematical discussion of this method, showing why it is often unsatisfactory, and suggests an improvement in which a resistance is placed in series with a galvanometer and in which the battery is also connected to a separate resistance representing its normal load, so that the measurement is made under the normal working conditions.

Measuring Apparatus.—In the "Jour. Teleg.," Jan. 25, Dr. Tobler describes a number of the newer forms of measuring instruments used in telegraphy.

Measuring the Power in Three-Phase Circuits.—Dr. Froelich's article is abstracted briefly in the Foreign Abstracts of the Institution of Civil Engineers.

Calculating the Coefficient of Self-Induction.—"L'Elec.," Feb. 10, reprints an Academy paper of Mr. Potier; it is of a mathematical character and refers to one particular case.

Absolute Measurement of the Flow of Electricity from Points.—An article by Mr. Precht on this subject is abstracted in the Foreign Abstracts of the Institution of Civil Engineers.

Mechanical Equivalent of Heat.—An abstract of Mr. Blondin's paper (see Digest Sept. 16 and 23) is given at some length in the February number of the "Jour. Inst. Elec. Engs."

Resistance of Pure Copper Wire.—Mr. Lagarde's article, mentioned in the Digest, is abstracted in the "Jour. Inst. Elec. Engs." for February, in which two tables of constants are given.

Conductivity of Certain Solutions.—The "Elek. Zeit.," Feb. 22, abstracts briefly a paper by Mr. MacGregory from the "Wied. Ann."

Theory of Units.—In a Presidential address by Mr. Francken, published in "Bul. de l'Assoc.. des Elec. Montifiore" for February, he discusses at considerable length the subject of units.

DYNAMOS AND MOTORS.

Alternating and Multiphase Currents from Continuous Current Armatures.—In the first part of an article by Mr. Friese in the "Elek. Zeit.," Feb. 15, he discusses systematically and clearly the E. M. Fs. obtained when a continuous current armature is provided with sliding contact connections for delivering alternating or multiphase currents of any number of phases. He assumes that the sums of the E. M. Fs. in the successive windings, when used as a continuous current machine, give a true sine curve, and that there is no phase difference between the current and the E. M. F., which would be the case in using it for incandescent lamps. Assuming that the E. M. F. for continuous currents is E, then if two diametrically opposite points are connected to sliding contacts, a simple alternating current will be obtained whose period is equal to the number of revolutions and whose E. M. F. will be equal to $0.707\ E$; the armature will then consist of two halves in parallel; if by a cross connection they be connected in series, the E. M. F. will be equal to $1.414\ E$, but forming in that case an open circuit armature; returning to the closed circuit armature, if 4 connections be made at 90°, the two currents, each from two diametrically opposite points, will each have an E. M. F. equal to $0.707\ E$, the phase difference being 90°; if each pair of connections 90° apart be used, a four-phase current will be obtained, the effective E. M. F. of each of which will be equal to $0.50\ E$; if three currents 120° apart are used, the effective E. M. F. will be equal to $0.612\ E$; for five-phase currents, $0.416\ E$; for six-phase currents, $0.3526\ E$; for eight-phase currents, $0.271\ E$, and for twelve-phase currents, $0.183\ E$. He also gives a general equation, a table of the results, an experimental verification and a graphical method for determining these constants.

In a continuation of the article in the issue of Feb. 22 he gives similar figures for open circuit armatures—that is when the armature is divided into separate portions, the beginnings of which are all connected to a common point—but the figures refer to the voltage between successive ends, and not to this common point unless so stated. For four portions and two circuits (two diametrically opposite portions connected in series), giving a two-phase current, the E. M. F. will be equal to $1\ E$. It is immaterial whether the circuits are connected to a common point or not, but if so, the voltage between this point and the end of a circuit is $0.5\ E$; for a three-phase current the voltage is $1.06\ E$, and from the common point $0.612\ E$; for four-phase currents, $0.707\ E$, and for the common point, $0.5\ E$; for five-phase currents, $0.489\ E$ and $0.416\ E$; for six-phase currents, $0.3536\ E$, which is the same whether taken at this end of the winding or between the ends and the common point; furthermore, in this case there is no difference between the closed circuit and the open circuit connection; for eight-phase currents, $0.2075\ E$ and $0.271\ E$; for twelve-phase currents, $0.0947\ E$ and $0.183\ E$. In conclusion he gives the general formula and the graphical solution; the article is to be continued.

Iron for Armatures.—The Lond. "Elec.," Feb. 23, in an editorial discusses unfavorably the recent paper of Mr. Schultz, abstracted in the Digest Jan. 20, in which he showed that paper insulation between armature discs was useless; the editorial concludes from this that it is useless to laminate the iron at all and questions the results. (In this editorial the conclusions appear to be entirely wrong, as the question which Mr. Schultz decided had reference to insulation and not to lamination, and he states it definitely; no one, and especially not Mr. Schultz, would for a moment suppose that it was futile to laminate the iron; he shows, in fact, that it is very necessary to do so; as we understand it, he has shown that the contact resistance between the plates forms sufficient insulation, therefore making the paper useless; nowhere in the original article is it even inferred that it is futile to laminate the iron, and this editorial is, therefore, very misleading.)

Dynamo Design.—Mr. Edgcumbe, in a practical article in the Lond. "Elec. Rev.," Feb. 23, describes the calculation of a dynamo by working out an actual example for a small series machine; (although the calculations are of a simple nature, he assumes a number of different dimensions and figures, which one who has not had considerable experience with dynamos might not be able to do); he first calculates the total number of lines, and from this the cross-section of the armature core, then the number of layers, then the magnets and their winding, and finally the losses; he shows how the calculations will differ in the case of a shunt ma-

chine and in the case of a motor; in conclusion, he gives very briefly several tables which simplify such calculations. Among the constants which he gives are the following: For the density in the armature, 8,000 lines per square centimetre; for the field cores, 10,000; for magnetic leakage, 20 per cent. loss for a two-pole horseshoe type with drum wound armature; for calculating the hysteresis losses by the Steinmetz formula he assumes the constant 0.004; he ignores the loss due to eddy currents, which are small.

A Difference Between Dynamos and Motors.—The "Elek. Zeit.," Feb. 15, publishes a paragraph forming an addition to the article abstracted in the Digest last week; it gives the results of a test showing experimentally that the shifting of the brushes is much greater, in this particular case more than twice as great, when used as a generator than when used as a motor.

Starting Resistance for Motors.—A device by Siemens & Halske is illustrated in "L'Elec.," Feb. 3; it consists of two carbons, like an arc lamp, the upper one being moved up by a solenoid, which, with the arc, is in series with the motor; on starting the motor an arc will immediately be formed, which, as the motor comes up to speed, will be diminished and finally extinguished, the normal current for the motor not being sufficient to draw the carbons apart.

Irregularities in the Action of Dynamos.—The translation of this article is concluded in the Lond. "Elec. Rev.," Feb. 23; in the same issue Mr. Slater discusses the article unfavorably.

Dynamo Attendants and Their Dynamos.—The serial by Mr. Gibbings is continued in the successive numbers of London "Electricity."

Electrically Driven Lathe.—In the "Elek. Zeit." Mr. Schultz gives a well illustrated description, including working drawings and a full view, of a lathe driven by an electric motor; the motor is under the lathe below the tool rest, and drives the spindle by means of a variable friction gear and toothed gearing; the motor runs at a constant speed, the only resistance required being that for starting.

Transportable Electric Pump.—The "Elek. Echo," Feb. 3, gives a short illustrated description of a pump made in Germany.

Dynamos for Lecture Purposes.—The "Elek. Rund.," No. 9, illustrates a number of different forms in a full-page illustration.

Patin & Lavasseur Dynamo.—"L'Elec.," Feb. 10, gives a well illustrated description of this dynamo, which consists essentially of eight radial magnets forming the armature, each of which is connected in five successive parts to as many commutator bars; the magnets appear to form the smaller part of the whole magnetic field.

Cail-Helmer Alternator.—The description from the French is abstracted at some length in the Foreign Abstracts of the Institution of Civil Engineers.

ARC AND INCANDESCENT LIGHTS.

Arc Lamps on Constant Potential Circuits.—In "L'Elec.," Feb. 3, Mr. Leroy discusses this subject by means of a diagram and shows that in the case of a single lamp the arc is stable only for a certain fixed resistance in series with the lamp, and the lamp should therefore not be adjusted for candle power by varying the resistance placed in series with it; in discussing two lamps in series, he shows how each is dependent on the other, and concludes that as there is only one condition under which they will run normally, only those carbons should be used for which the constructor has adjusted the lamp, and after the resistance has been once adjusted it should never be altered; he also calls attention to the importance of properly adjusting the carbons in their holders.

Street Lighting.—In an editorial on this subject the Lond "Elec.," Feb. 23, compares gas, arc and incandescent lighting; it concludes that where electric energy costs less than 8 cents per kilowatt hour and gas costs 62 cents per thousand cubic feet, or in this proportion, the competition of incandescent lamps with gas lamps becomes practicable; it estimates that, light for light, the cost of the incandescent light is, roughly, six times that of the arc; it does not recommend diffusers, but thinks that the use of small arc lamps has not been given a fair trial, and suggests the use of 5 and 6 ampere arc lamps, with large positive and small negative carbons, run in series of 5 on the outer wires of a three-wire system.

Search Lights on the Manchester Canal.—The Lond. "Elec. Eng.," Feb. 23, mentions, but does not describe, a powerful search light, making night navigation possible; it is said to cause no inconvenience to vessels coming in the opposite direction, but it does not describe how this is accomplished.

Parabolic Reflectors.—"La Lum. Elec.," Feb. 10, gives an illustrated description of the Schuckert apparatus for making these reflectors.

Projecting Lamp.—An illustrated description is given in the "Elek. Echo," Feb. 3.

Properties of the Alternating Current Arc.—The experment of Mr. Claude, mentioned in the Digest last week, is described more in detail, with the aid of three illustrations, in "La. Lum. Elec.," Feb. 10.

Alternating Current Arc.—The investigation of Mr. Blondel, abstracted in the Digest last year, is abstracted in the Foreign Abstracts of the Institution of Civil Engineers.

Arc Lamps.—In Mr. Richard's serial in "La Lum. Elec." he describes and illustrates a number of arc lamps and appliances.

Cored Carbon Litigation.—The "Elek. Rund.," No. 9, contains a note on this subject.

Arc and Incandescent Lamps.—Mr. Baineville's article, mentioned in the Digest Sept. 23, is abstracted briefly in the Foreign Abstracts of the Institution of Civil Engineers.

Multiple Filament Lamps.—Mr. Leconte, in "L'Elec.," Feb. 17, shows that this form of lamp was first patented in France in the year 1883.

Contact Lamp.—"L'Elec.," Feb. 3, gives an illustrated description of the Schroeder lamp, in which a carbon rod is fed upward by means of mercury against a piece of iridium.

TRANSMISSION OF POWER.

Power Transmission in Norway.—According to the Lond. "Elec.," Feb. 23, it has been proposed to transmit some 20,000 h. p. from two waterfalls to Christiania, a distance of about twenty-five miles; the voltage will not exceed 20,000, and the idea is to use bare wire on poles carefully guarded along their whole length; in the city it will be reduced to 100 and 400, and is to be used for power in the different industrial establishments, both large and small, for street railways, local railways and local steamers; also for lighting the city; it may be completed before the end of 1895; the estimated cost is about one and one-half million dollars.

Transmission of Power at Niagara Falls.—The complete paper of Prof. Forbes, together with the discussion, is given in the February issue of the "Jour. of the Inst. of Elec. Engs."; a number of the illustrations appear to be published here for the first time.

ELECTRIC RAILWAYS.

Heilmann Locomotive.—The Lond. "Elec. Rev.," Feb. 23, discusses this system; after ridiculing it, it does not agree that the reciprocating parts are abolished; it claims that 100 miles an hour, which has been obtained in America with ordinary locomotives, can also be obtained and with greater

safety by English locomotives; the unbalanced counterweight can be gotten rid of entirely by the use of three cylinders, the central one having moving parts of double the weight of each of the outer ones; it thinks too much stress is put upon the adhesion, as it is only at low speeds that a single pair of drivers is insufficient; every claim regarding the advantage of having no direct connection between the engine and the driving wheels, it states, could also be had with less loss of efficiency by a system of rope driving.

According to "L'Elec.," Feb. 10, a weight of 530 tons, including the locomotive, was started on a curve of about 400 feet radius, and it is claimed that 630 tons, not including the locomotive, can be started if the eight motors are connected four in series. Mr. Lea, in the Lond. "Elec. Eng.," Feb. 23, gives a vertical cross-section of the high speed vertical exciting engine.

Proposed Alpine Electric Road.—According to the "Elek. Zeit.," Feb. 22, it is intended to build an electric road from the Scheidegg to the top of the Jungfrau, one of the highest and most magnificent of the snowclad Alps; (the greater part of this road would be above the eternal snow line); owing probably to the frequent avalanches, a great part of it will be in tunnels or half tunnels, as on the well-known Axenstrasse; the road will terminate on a plateau free from snow, almost 14,000 feet above the level of the sea and about 200 feet below the top; for this last portion there is to be an elevator; the total length is about 7 1-2 miles; the power for the current is to be furnished by the mountain streams; the first portion of the road is to be finished in two years, and the rest in the following two years; it is to cost one and one-half million dollars; a neighboring water power of 1,840 h. p., it is thought, will be sufficient.

Rules and Regulations.—The Lond. "Elec.," Feb. 23, gives, in a parallel column form, the proposed Board of Trade regulations, with the suggested alterations and the source of such suggestions; the Lond. "Elec. Rev.," Feb. 23, gives a short abstract of a meeting at which they were discussed; the Lond. "Elec. Eng." discusses the subject editorially. We will reserve our abstract until further action is taken regarding their adoption.

Welding Rails.—According to "La Lum. Elec.," Feb. 17, 1 kilowatt is required per square centimetre during six minutes, and as the rails used in France do not exceed 60 square centimetres in cross-section, the cost of one welding is 82 cents, the price of the energy being taken at 10 cents per horse power hour.

Underground Sectional Railway.—"La Lum. Elec.," Feb. 10, mentions, but does not describe, a system of Mr. Chabeault, which was recently tried in Marseilles, in which an underground conductor is connected by the car to insulated sections of a surface conductor as it passes over them.

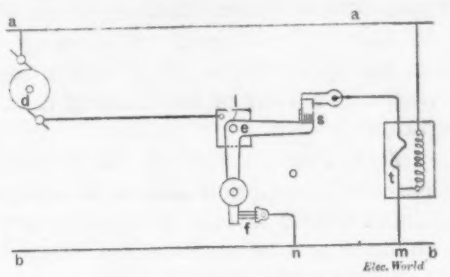
Genoa.—"La Lum. Elec.," Feb. 10, reprints a description from the Italian of the electric railway installed by Siemens & Halske, some of the features of which differ materially from the practice in this country; the article includes eight illustrations.

Remscheid Railway.—An illustrated description is begun in London "Electricity," Feb. 23.

Railways.—Mr. Richard's well illustrated serial, taken apparently from patent specifications, is continued in "La Lum. Elec.," Feb. 17, most of the descriptions being of American inventions.

CENTRAL STATIONS, PLANTS, SYSTEMS AND APPLIANCES.

Switches.—The Lond. "Elec.," Feb. 23, calls attention to a number of new switches and other appliances of the English Brush company, illustrating and describing a return current fuse, intended to render the parallel working of alternators perfectly safe; as the fuse melts only with the return current, but not with the current transmitted from the alternator, it will thus cut out the faulty alternator, when several are in parallel, and not those which are not faulty, in which it differs from the simple fuses; the device is shown in the adjoining cut; *f* is the fuse, *e* a lever switch and *t* the



RETURN CURRENT FUSE.

accelerator, consisting of a small transformer; at *e* the current divides before going to the main *b*; the accelerator increases the voltage about half a volt, which is sufficient to induce the current to select that path in preference to that through the fuse, but if the current returns from the mains to the alternator, the accelerator acts as a retarder and forces the current through the fuse.

Switch for Explosive Surroundings.—The Medhurst switch is illustrated in "L'Elec.," Feb. 3; the contact is made by means of mercury or shot in the inside of a hermetically sealed vessel which can be turned on its axis.

Utilization of Small Waterfalls.—An article from the French by Mr. Chedeville is abstracted in the "Jour. Inst. Elec. Engs."; he shows the advantages of storing the water in a reservoir and gives an example in which the waterfall utilized directly would light 75 lamps of 16 c. p., while if stored in a reservoir 25 times the number can be run during six hours in winter and two hours in summer; if stored in electric accumulators only seven times the amount can be obtained.

Bournemouth Accident.—The Lond. "Elec. Rev.," Feb. 23, discusses this accident, in which the current which killed a horse must have come directly from the ground and gone into the ground again; attention is called to the fact that although the megohm resistance of a wire may be high, yet the thickness of insulation may leave no margin of safety; it has been recommended by the government inspector that the insulation of high tension leads should not be less than one-tenth inch in thickness and that the enclosing pipes should all be connected together and earthed; the result of the inquiry shows that for high voltages concentric mains are distinctly preferable to and safer than parallel cables.

Balancing a Three-Wire Station with Only One Machine.—In the Lond. "Elec. Rev.," Feb. 23, Mr. Gibson describes and illustrates a system in which a single armature containing two windings and two commutators is used together with accumulators; by means of the station lamps either of the batteries can be charged independently of the other and at any desired rate, while the voltage of the mains is balanced with the battery.

Rotating Field Apparatus.—Mr. Blondel's mathematical paper on the elementary theory of such apparatus is continued at considerable length in "La Lum. Elec.," Feb. 10, and concluded in the issue of Feb. 17. In this article he has discussed polyphase currents and rotating fields in general, and indicated what appears to be a new and complete method of calculation; in a table in the conclusion he gives some comparative figures regarding the weight of copper, loss of energy, etc., for a number of different conditions.

Multiphase Currents.—An article by Mr. de Chasseloup-Laubat is published in the Foreign Abstracts of the Institution of Civil Engineers; he shows, among other things, how the intensity of the field, the mechanical working done by the armature, the losses, self-induction, etc., may be calculated.

Pollak Rectifier.—The "Elek. Zeit.," Feb. 22, gives a short, well illustrated description of this apparatus, which has already been described in these columns; its efficiency is given by the inventor as 99 per cent.

Ferranti Rectifier.—The Lond. "Elec. Eng.," Feb. 23, mentions that the apparatus of Mr. Ferranti is now being made and tried with a view of introducing it in Cardiff for arc street lighting.

Fuses for High Tension Circuits.—"L'Elec.," Feb. 3 gives an illustrated description of the Webber & Nisbett fuse, in which the wire is wound spirally around a non-conductor and enclosed in a tube, the whole being conveniently arranged for placing it in circuit.

Train Lighting.—In the "Bul. de la Soc. Belge," for August-September-October, Messrs. Dery & Weissenbruch give, at considerable length, an illustrated description of existing installations, both in Europe and America; the question of costs is reserved for a subsequent article; this forms probably the best summary on this subject.

A long paper by Mr. Grawinkel and its discussion, on the electric lighting of the German mail cars, is reprinted in full in the "Elek. Zeit.," Feb. 22; he describes the installation and gives a diagrammatic drawing of the switchboard.

Installations.—The "Elek. Zeit.," Feb. 15, notices at some length a recent publication of the German Electric Company prepared for those who intend to instal plants; the first part is devoted to a discussion of the general principles and the second to a general guide for making approximate calculations of the cost, both parts including lighting and transmission of power plants.

Regulations for Installations.—The "Elek Zeit.," Feb. 15, publishes a recent discussion of this subject in the Engineering Society in Hamburg.

Advantages and Disadvantages of Alternating Currents.—Mr. Snell discusses this subject in his serial on motive power in the Lond. "Elec.," Feb. 23.

Lighting from Primary Batteries.—In the "Elec Tech.," Jan. 31, Mr. Wagner discusses the requirements, but gives nothing new.

Berlin.—The Elek. Zeit.," Feb. 15, gives a brief summary of the electric lighting in that city for April 1, 1892, and April 1, 1893; the consumption of gas decreased about one million cubic metres, while the increase in the electric light was considerable; the number of private installations operated by steam engines diminished about 50 per cent., while those driven by gas motors increased almost 50 per cent., and in 1893 were more than double those driven by steam engines; the total number of arc lamps in the two years were 8,020 and 8,800, showing an increase of 780 lamps; incandescent lamps (presumably 16 c. p.), 140,276 and 172,067, an increase of about 32,000 lamps; the equivalent of all the electric lights in gas lamps is estimated at about 225,189.

A brief description of several of the Berlin stations is given in the "Bul. de la Soc. Belge" for August-September-October.

London.—Major General Webber's paper is continued in the English journals of Feb. 23; it includes a number of cuts illustrating various systems of underground conduits; the Lond. "Elec." contains a few more cuts than the other journals.

London Central Stations.—The Lond. "Elec. Rev." and "Elec. Eng.," Feb. 23, give the accounts of several stations in Great Britain; the Lond. "Elec. Eng.," in its advertising pages, gives an analysis of the Board of Trade returns.

Paris.—A full page illustration of an interior view of the Halles station in Paris is given in the London "Electrical Plant" for February.

Electrical Industry in the United States.—Mr. Brunswick's serial in "La. Lum. Elec.," is continued in the issue of Feb. 17; it includes a full-page table of statistics for a number of the principal cities of the United States, giving the number of arc and incandescent lamps, the power, capital and the names of the systems; also another full-page table, giving the data for a number of different installations in reference to meters, their capacity and the method of payment, etc.

Multiphase Current Systems.—"Ind. and Iron," Feb. 16, in an editorial calls attention to a patent of Mr. Frank Wynne, September, 1886, which it believes was the first "multiple current system" (by which term is apparently meant what is here called multiphase system); the machine is described as being similar to a Brush dynamo with collector rings, thus delivering separate alternating currents of different phases; these were led to different points and transformed down to a low pressure, after which they were passed through a commutator driven by a synchronous motor, thus producing direct currents of low pressure; it believes that such a system is better in most cases than the employment of multiphase motors.

Electric Lighting Statistics.—The "Elek. Rund.," No. 10, contains an article by Mr. Paisler, in which he gives some statistics for cities in Germany and England.

Erding.—An abstract of the description of this three-phase station is given in the Foreign Abstracts of the Institution of Civil Engineers.

St. Pancras.—The Lond. "Elec. Rev.," Feb. 23, in an editorial discusses unfavorably the recently published description of this station.

Nottingham.—The Lond. "Elec. Eng.," Feb. 23, gives a brief description of this station with a number of large illustrations, limited entirely to the architectural features.

Bockenheim.—An abstract from the French of the description of this polyphase station is given in the "Jour. Inst. Elec. Engs." for February.

Darmstadt.—The "Elek. Zeit.," Feb. 22, abstracts at some length the accounts for this station.

Automatic Gas Engine Starter.—A description of the Niel starter, taken from "Genie Civil," is given in "La Lum. Elec.," Feb. 17, including an illustration.

Solidified Petroleum as a Fuel.—The Lond. "Elec.," Feb. 23, abstracts from a French journal a method of making fuel bricks of crude petroleum.

Combustion Without Smoke.—"L'Elec.," Feb. 10, gives an illustrated description of the Baumert & Wegmer system.

Direct vs. Rope Driving.—The discussion in the Lond. "Elec. Rev." is continued in the issue of Feb. 23.

WIRES, WIRING AND CONDUITS.

Rules and Regulations for Ship Lighting.—In a second article of Mr. Kennedy in the Lond. "Elec. Rev.," Feb. 23, he discusses fittings, giving illustrations of a faulty form as often used, and two other forms, one for single and one for double wiring, which, though more expensive, are much safer, and have other advantages; he criticises the absurdity of the rules which require the mains to be kept a great distance apart, but permit the branch wires to be brought very close together, with little protection from each other in the fittings; rules ought to make it impossible to adopt a bad system and should insist on the use of properly constructed junction boxes, switches, fuses and fittings; joints should be reduced to a minimum and fittings should be made so that they can be taken down and put up without making any joints.

Wiring on Shipboard.—The Lond. "Elec. Rev.," Feb. 23, under the heading of "Jerry Wiring for Ships," gives a number of interesting illustrations of actual specimens of wiring found on board of some ships.

Regulations Regarding Electrical Conductors.—"L'Elec.," Feb. 3, publishes the proposed laws regarding conductors; they are also given in "La Lum. Elec.," Feb. 10.

Explosions in Manholes.—The Lond. "Elec.," Feb. 23, suggests, in an editorial, an instrument to measure the percentage of hydrogen in a manhole without lifting the cover, and based on the high rate of diffusion of light gases through porous partitions.

Underground Conduits in London.—In the portion of Major General Webber's paper published in the English journals, Feb. 23, a number of cuts are given of the systems used in London.

TELEGRAPHY, TELEPHONY AND SIGNALS.

Telegraphy Between England and India.—The Lond. "Elec. Eng.," Feb. 16, gives a brief abstract of Mr. Walker's paper, mentioned in the Digest last week.

Railroad Signals.—The "Elek. ," eb. 8, reprints from the London "Engineer" of July 29 an illustrated description of the Sykes system, in which the signals are moved in both directions.

Review for 1893.—The "Jour. Telegraphique," Jan. 25, gives a review of the telegraph and telephone for the past year, including a number of comparative tables.

Telegraph and Telephone Line Construction in Germany.—An abstract of the article of Mr. Kohlman is given in the Foreign Abstracts of the Institution of Civil Engineers.

Telegraphy Between England and India.—Mr. Walker's paper is abstracted in the Lond. "Elec. Rev.," Feb. 23, and is discussed in a short note in the same issue, and in a long editorial in "Ind. and Iron," Feb. 23; the Lond. "Elec.," Feb. 23, publishes a report of the discussion.

Telegraphs of Queensland in 1892.—An article on this subject is given in the "Jour. Teleg.," Jan. 25.

Long Distance Telephone.—The Brown Telephone is illustrated and described in "La Lum. Elec.," Feb. 17.

Telegraphs and Telephones in Spain.—The "Jour Teleg.," Jan. 25, gives a summary of the years 1890 and 1891.

Electrical Wakening Apparatus for Hotels.—In the "Zeit. feur Elek.," Feb. 1, Mr. Vianen describes, with a full-page illustration, an apparatus for hotels for sounding an alarm in any desired room at any desired time.

Bells for Damp Places.—"L'Elec.," Feb. 3, illustrates the Hoffmann bell, in which both the magnet and the contact are in hermetically sealed cases, the latter having a flexible diaphragm, through which the vibrator is operated by the clapper.

Railway Signals.—The Daves signal is illustrated and described in "La Lum. Elec.," Feb. 17.

Train Signals for Single Lines.—The Mene process is described and illustrated in "La Lum. Elec.," Feb. 10.

ELECTRO-CHEMISTRY.

Purification of Sewage.—Mr. Hermite estimates that it would cost $12,000,000 to change the present system in Paris to the one devised by himself.

Extraction of Zinc.—The Lond. "Elec. Eng.," Feb. 23, mentions, but does not describe, a process tested in Sweden, giving satisfactory results and described in "Engineering"; the main feature is that it can be applied to ore of very poor quality, like sulphur ore, the metal being equal to the best zinc in the market.

Iron Ore Extracting Process.—"Ind. and Iron," Feb. 23, mentions, but does not describe, the De Laval process, which is to be tried in Sweden, the current for which is to be supplied from a waterfall; the process is already spoken of as likely to effect a revolution in the Swedish iron industry.

Electrolysis of Chloride of Sodium.—The apparatus for the Cutten process is described and illustrated in "La Lum. Elec.," Feb. 10.

Liveing Electrolyzer.—From an illustration in "La Lum. Elec.," Feb. 17, the anodes are made of blocks of carbon placed in a closed vessel with a perforated bottom, contact being made with a carbon plate from their top surface held there by pressure.

Diaphragm.—Mr. Waite, in the "Zeit feur Elek.," Feb. 1, describes an improved diaphragm made of asbestos, the pores of which contain gelatine; it is intended to be used in the electrolysis of alkaline salts.

Electrical Inlayer in Metals.—The "Elec. Tech.," Jan. 31, describes a process in which the metal is first etched and afterward filled in with another metal by electrolysis.

Galvanoplastic Apparatus.—The article in the "Elec. Tech." is continued in the issue of Jan. 31.

Clubbe & Southey Accumulators.—According to "La Lum. Elec.," Feb. 10, the positive plates are made of active material lying horizontially in perforated trays, and containing a conductor in the middle; negative plates rest on top of these, separated by insulators.

Raab & Bastian Accumulator.—According to "La Lum. Elec.," Feb. 10, the electrodes consist of vertical rods of a star shaped cross-section enclosed in cylinders having numerous openings, thus preventing the active material from falling off from the electrodes.

Accumulators.—In an elementary article by Mr. Duerler in the "Elec. Tech.," Jan. 31, he attributes the discovery of the secondary reaction of lead in sulphuric acid to Sinsteden in 1854.

Hellesen Dry Cells.—A good illustrated description, with some curves and tests, is given in "L'Elec.," Feb. 10.

Dry Cells.—The "Elek. Zeit.," Feb. 22, criticises unfavorably the recent tests of Mr. Zacharias, mentioned in the Digest some weeks ago.

Polarization of Thin Metal Partitions.—The first part of a paper by Mr. Daniell is given in the "Phil. Mag." for February; several illiustrations and tables of results are given.

Velocity of Ions.—The "Elek. Zeit.," Feb. 15, abstracts at some length, a recent paper of Prof. Kohlrausch in the "Wied. Ann.," volume L., page 385.

Sodium Silicate Solutions.—The "Elek. Zeit., Feb. 22, abstracts an article by Prof. F. Kohlrausch on this subject.

MISCELLANEOUS.

Electric Tempering.—According to the "Elec. Tech.," Jan. 31, the Lagrange & Hoho system has been used with great success for tempering certain objects; the bearing part of a shaft, for instance, was tempered glass, hard to a depth of about 3-4 inch, while the interior was retained quite soft; with flat springs and files the trials were not a success, files, for instance, heated much more at the points than at the larger parts, and in thin springs the heating was unequal; in a gun factory at St. Etienne very good results were obtained, one man being able to temper 2,400 steel wire springs daily; unsuccessful results are reported from Kalk.

Ozone.—"La Lum. Elec.," Feb. 17, states that Dr. D'Arsonval has obtained ozone without any special apparatus by the action of alternating currents on liquid oxygen; the quantity of energy required for transforming oxygen into ozone is considerable, and an influence machine is therefore quite insufficient for producing anything but small quantities; a short description is given of how he prepared liquid oxygen.

Manufacture of Mica Plates.—The description of a French process is abstracted in the "Jour. Inst. Elec. Engs."; small pieces of mica are cemented together by shellac, the mass being compressed and heated.

Effect of Electricity on the Carburation of Iron.—An article of Mr. Garnier from the French is abstracted in the "Jour. Inst. Elec. Engs."

Globular Lightning.—The "Zeit. feur Elek., Feb. 1, describes a recent case in an Austrian post office; the lightning appears to have struck some distant telegraph lines, after which a very bright ball of light about three inches in diameter exploded with a very loud noise in the room, but without doing any damage; it was observed by a number of persons.

Effect of Lightning Upon Trees.—The Lond. "Elec. Eng.," Feb. 23, abstracts briefly the recent paper by Mr. Dimitrie, abstracted in the Digest some time ago, in which the relative conductivity of different trees is given.

Fire Damp Measures.—"La Lum. Elec.," Feb. 17, describes briefly the Coquillon apparatus, in which the gases are burnt by means of a heated platinum wire and afterward analyzed; 0.25 per cent. of fire damp was easily detected; it is said to be the only apparatus by means of which a sufficiently exact analysis can be obtained.

Electric Door Opener.—An illustrated description of a device is given in the "Elec. Tech.," Feb. 15.

Autoconduction.—An investigation regarding the priority of invention of the therapeutic application of currents induced in the body, showed that this method was first used by Boudet in 1877, but that Dr. D'Arsonval first used currents of very high frequency in this manner.

Emissive Power of the Skin.—A note in the January number of the "Bul. de la Soc. Int. des Elecs." mentions an experiment by Mr. Lecercle on the modifications of the emissive power of the skin under the influence of an electric brush discharge.

Central Station Currents in Therapeutics.—Mr. Gaiffe' paper is published in full in the January number of the "Bul. de la Soc. Int. des Elecs."

Electricity in Medicine.— A paper by Dr. Bloebaum is reprinted in the "Elek. Rund.," Nos. 9 and 10.

New Book.

DYNAMO AND MOTOR BUILDING FOR AMATEURS. With Working Drawings. By Lieutenant C. D. Parkhurst, U. S. Army. New York: The W. J. Johnston Company, Ltd. 162 pages, 71 illustrations. Price, $1.00.

The author, in his preface, states that this book is an attempt to describe such forms and types of motors and dynamos as are simply and easily made, and yet such as will produce fairly efficient results as a return for the outlay of money, time and patience on the part of the builder, and prove profitable as actual working models, as well as through the instruction given in their construction. It is presumed, he adds, that the builder has a fair knowledge of the machinist trade and the handling of the necessary tools; hence no attempt has been made to try and tell how these tools are to be used. Only such hints as the author has found to be of benefit to himself are given, the rest being left to the knowledge and skill of the amateur. It is not presumed or assumed that the amateur must follow implicitly the instructions or data given for the various machines; experiment and research will teach many things, and possibly and probably give as good results as a blind following of any data. So long as the grand underlying principles of dynamo construction are known and followed, the amateur cannot go far astray, and the types of machines given in the book are to be taken as a few samples of the many forms that have been successfully built by others, and that may be again built by any one.

The instructions in this book are clear and concise and accompanied by working drawings. While primarily intended for the amateur, the detailed information, particularly in the chapters on armature windings, connections and currents and on the design of a 50-light incandescent dynamo, will be of value to every electrician.

Full descriptions and working drawings are given for the following machines: A small bipolar shuttle armature motor of simple construction, capable of driving a small ventilating fan with current from a primary battery; a small motor for driving a sewing machine, for which no castings or patterns are needed; a sewing machine motor of more finished appearance and of greater efficiency than the above, being of a regular factory-made type, and a dynamo of modern type, capable of lighting 50 16-candle power incandescent lamps of 125 volts.

A chapter on armature windings, connections and currents gives minute instructions, illustrated by drawings, in regard to these subjects, and based upon the latest and best practice. The chapter on the 50-candle power dynamo will be found instructive aside from the construction of the dynamo, as all of the technical points involved in the design are fully treated, such as the proportioning of the armature and windings, calculation of the magnetic circuit, etc.

In an appendix data of some high-class dynamos and motors are given that will be of assistance as guides should the amateur wish to design any other types than those treated in the book.

Thomson Recording Wattmeter for Arc Circuits.

The success which the Thomson wattmeter for incandescent circuits has experienced has prompted the General Electric Company to design a recording wattmeter especially for the measurement of energy used in groups of arc lights in commercial lighting, such as in stores, factories, halls, and the like. This meter is the outcome of two and a half years of careful investigation and experiment. Indeed, probably no other meter or instrument manufactured by the General company has received more careful study than this meter. It is a true watt meter, modified in its principles only to meet the change of conditions of arc light service. It is similar in construction to the well-known Thomson record-

THOMSON WATTMETER.

ing watt meter, and has the same damping device—a copper disc and two permanent magnets. It has been designed on the lines of an arc lamp, so far as its location, etc., are concerned; that is to say, to be suspended from the ceiling by two brass rods fastened to a simple ceiling board, and the same object is attained as in the suspension of arc lamps from the ceiling—the meter is inaccesible except to those who understand its manipulation. A special feature is the safety cut-out contained within the cover proper. The meter is designed to close immediately on possible trouble occurring within it, which might result in the burning out or breaking

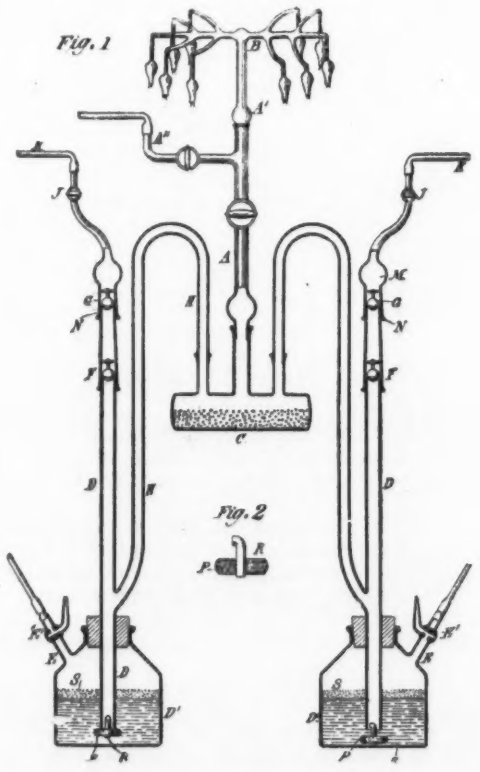
of the circuit. The cut-out serves to short circuit the meter and cut it out, rendering trouble in the meter impossible. At the same time it preserves the continuity of the circuit and permits the lights to burn without interruption, an advantage sufficiently obvious.

The connections of the meter are exceedingly simple. The connection blocks are at the top, the wires being brought first to the ceiling board, then dropping to the meter. The two terminals farthest from the front of the meter are connected to the line through an absolute cut-out, the two front terminals being connected to the lamps in the house. So far as the operation of the meter is concerned, it makes no difference which wire is positive and which negative, though, of course, to have the lamps to burn correctly, attention will have to be paid to this point. No trouble will be caused if the lineman should make a mistake and connect the wires which should go through the front terminals to the back and vice versa; there will be no short circuit or burning out. The meter will run backwards but register correctly, subtracting instead of adding to the sum on the dial.

The meter is shipped fully assembled and ready for installation. Careful tests show that the same accuracy can be expected on a minimum load as on a maximum, and this accuracy is of the highest.

Mercurial Vacuum Pump.

Among recent developments in the incandescent lamp field is a new and improved type of mercurial vacuum pump, recently patented, which, it is claimed by the makers, R. P. Ashwell and J. A. Vandergrift, 293 North Seventh street, Newark, N. J., will prove an important factor in determining the question of how to decrease the present price of lamps without sacrificing their quality. It will be noticed that while the well known Geissler principle is used, this pump differs from the usual Geissler forms quite essentially,



MERCURIAL VACUUM PUMP.

and can be briefly characterized as to its principle by the word "tubular."

It is the adherence to and development of this tubular principle that have enabled the inventors to obtain a great increase in pumping capacity and a consequent decrease in the total expense of exhausting. One pump, as at present constructed, using 45 pounds of mercury, exhausts to the highest degree 10 lamps in 30 minutes from the time the lamps are first put on, as compared with three hours required to exhaust the same number of lamps by the usual Geissler form of pump.

A brief comparison between the new tubular pump and the usual Geissler form, based on capacities, as stated above, taken from actual practice, has been communicated to us by the makers and is given below; for purposes of comparison, 1,000 lamps are taken, to be exhausted to the same degree in 10 hours, from which calculations for other outputs can easily be made.

	New Tubular.	Usual Geissler.
Number of pumps	7	34
Horsepower of boiler and engine	7	34
Capacity of dynamos	70 lt.	350 lt.

Floor space, $12' \times 5' = 60$ sq. ft., and $35' \times 10' = 350$ sq. ft.

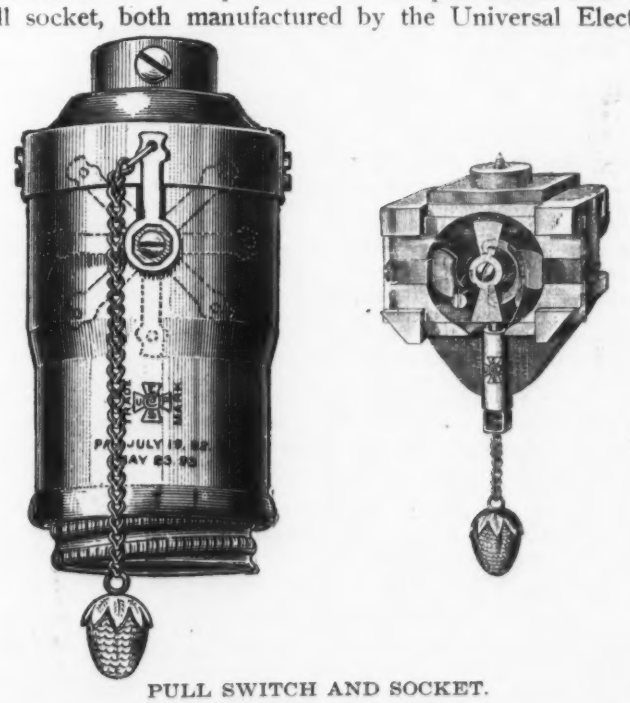
The above comparison shows that the ratio of the various items is about as 5 to 1 in favor of the tubular pump, and more detailed and exhaustive calculations, also taken from actual results, confirm this ratio, it is claimed. The important bearing which the above figures have upon not only the original outlay, but also in respect to interest on the power plant and building, will be readily perceived, as it is a well known fact that the pump department has hitherto occupied more space than any other department, and that at least 80 per cent. of the total power generated is absorbed by this department.

The makers claim that numerous and long continued tests upon lamps exhausted by this tubular pump have demonstrated that there is a decided gain in the quality of the lamps over those exhausted by the old form of pumps.

One single tube will operate about 14 times a minute. This is controlled by a three-way stop cock connected with a mechanical air pump, and also with the atmosphere, and operated by an electromagnet, which can be set to exhaust 14 times a minute.

Pull Switch and Pull Socket.

We illustrate an improved form of a pull switch and of a pull socket, both manufactured by the Universal Electric



PULL SWITCH AND SOCKET.

Pull Socket and Switch Company, 27 Beaver street, New York, and described originally in The Electrical World of Oct. 21 and 28, 1893. The improvements are in the direction of simplicity and add still further to the value of these useful appliances.

Financial Intelligence.

The Electrical Stock Market.

New York, March 10, 1894.

THE ELECTRICAL STOCK MARKET is evidencing, by improved quotations, the continued presence of bettered business conditions. Investors are beginning to recognize the fact that industrial securities of legitimate business corporations offer unusual inducements for the investment of capital, and some of the large amounts of money idle is quietly finding its way into the channels of investment represented by electrical corporations.

GENERAL ELECTRIC has been strong all the week; at times the price has fairly danced upward. Advices from all quarters on the company's prospects continue of the most bullish character, and the friends of the General Electric can now be counted among the most powerful interests in Wall street. Drexel, Morgan & Co. are the leaders in the talk that the company is in a fair way of improving its condition and business. The talk is "that it has been able to pay off all its indebtedness, and has on hand several contracts of a very advantageous nature. The removal of the plant to Schenectady is said to have made a saving of from 20 to 25 per cent. in expenses." Despite Mr. H. McK. Twombley's denial, Wall Street still believes that the Vanderbilt interests will be put in control next month. A good representation will be put into the directory and a Vanderbilt man may be elected president. Then it is now stated that present business is allowing the company such a margin of profit that the deferred dividend on the preferred is confidently expected to be paid in May. Whatever the facts of the situation may be, the strength of the stock has convinced a good many bear traders of the necessity or desirability of covering short contracts. But some of the operators on the bear tack are not yet dismayed, and insist that they are fully warranted in predicting lower prices. First of all, they argue that the competitors of the General Electric Company are getting all its business away from it; that what it does get is taken at prices that do not allow of a profit, that the strength the stock displays is not due to the buying for the bull side, but to covering of scared shorts. They continue to talk of a reduction in capital stock; a 50-per cent. reduction in the amount of common stock is said to be necessary to make up for the shrinkage in assets. Naturally, if the common stock holders make this concession, preferred shareholders must give way, some by foregoing a portion of their dividend rate and allowing the dividend to be non-cumulative. It is said that the directors would be personally liable if they declared a dividend when the capital was impaired and a profit and loss deficit in the annual report is foreshadowed; therefore the talk about cutting down the common stock. The most convincing argument on both sides, however, is the fact that somebody is buying and that that buying is putting up the stock. It closes for the week at 2¼ points above last Saturday's quotation.

WESTINGHOUSE ELECTRIC stocks continue in good favor. The company has just declared the quarterly dividend of 1¾ per cent. on the preferred; it is payable April 2. It is reported that in the last eight months the company has reduced its debt by one-half, and will stand clear of debt by the end of 1894. Saving an issue of $500,000 sub-company bonds guaranteed, there are no charges ahead of the preferred, which is preferred not only as to dividends with the cumulative provision, but also as to assets. Naturally, if the common stockholders make this con- the subject of much favorable comment. It is argued that the only reason for the preferred stock being under par, lies in the fact that the stock is so closely held by investors that the amount offering for sale is too limited to admit of spirited speculation, with attending quickly rising quotations. There is, of course, no inherent weakness in the stock. The company has now gone into the arc light field, and is offering arc lights at prices so far beneath the figures obtained by its rivals that its volume of trade will be extended more than ever. It is claimed now that the Westinghouse company does 70 per cent. of the entire business handled by it and the General Electric Company, and on a capitalization, par value, of $9,089,640, as compared with the General Electric's capital of $44,708,900. Relative to a rumor set afloat this week, an official says: "The Westinghouse Electric Company has not taken any securities during the past year or two in payment for apparatus. The company's sales have all been for cash or for short time paper. The latter has been taken only with bonds as collateral, and only in a few cases."

WESTERN UNION TELEGRAPH has been well supported all the week. Advantage has been taken, however, of the raised quotations to market some stock, insiders selling. It is intimated that, while the quarterly statement to be presented at next Tuesday's meeting of the executive committee may not be interpreted favorably, there will be a surplus after paying the regular dividend of 1¼ per cent., thus demonstrating the enormous earning capacity of the property even in periods of protracted depression.

EDISON ELECTRIC ILLUMINATING has been stronger on the favorable decision handed down this week by the Court of Appeals in its suit against the State Comptroller, the appeal being from an order of the General Term affirming the decision of the Comptroller and imposing certain taxes upon the company for the years 1886, 1887 and 1888. The court holds that the company was not liable for the tax on capital stock during these years, and that it is entitled to a review of the proceedings levying the taxes.

THE COMMERCIAL CABLE COMPANY held its annual meeting this week. The annual report shows gross earnings for 1893 of $1,842,346, and a balance, after paying expenses of $784,600,, of $1,057,746. Net earnings, however, are $41,840 behind the net earnings of 1892. Debenture bonds to the amount of $600,000 were paid off during 1893, and provisions made to pay off during the year the rest of the entire outstanding indebtedness—a matter of about $400,000. The dividends of 7 per cent. were regularly declared and paid. The old board of directors was re-elected. The annual report goes on to say that the whole system is in excellent condition and that the company has contracted with Messrs. Siemens, Brothers & Co., of London, England, for the manufacture and laying of a third cable, to be completed by the middle of July.

THE STREET RAILWAY AND ILLUMINATING PROPERTIES trustees are again in the field for the purchase of preferred stock. They invite proposals for the sale to them of as many preferred shares issued on the trust deed of Aug. 18, 1893, as can be purchased with $200,000.

THE ELECTRIC TRACTION COMPANY of Philadelphia has called for remaining installments on its capital stock, aggregating $25 per share, by Arpil 15, when the stock will be full paid. The stock has had quite a substantial rise of late.

BELL TELEPHONE STOCK has been prominent in Boston this week. Covering of shorts has caused most of the present advance, though at the highest price there has been free realizing, causing some recession in values. The counsel of the company says that, if the petition to increase the capital stock to $10,000,000 is granted, the new capital will all be immediately spent on long distance lines in extension of the service. No objection is made by the Bell company to the organization of other telephone companies. They rely on their first presence in the field and their established business methods to keep on earning money. It is remarked that there are 5,227 Bell telephone stock holders; of these 3,721 hold less than 25 shares apiece, the average for the rest being about 70 shares apiece.

ELECTRICAL STOCKS.

	Par.	Bid.	Asked.
Brush Ill., New York	50	20	35
Detroit Electrical Works	10	2	3
Cleveland General Electric Co	—	85	90
East River Electric Light	100	—	65
Electric Con. & Supply Co., pref	15	15	16
" " " " com	15	15	17½
Edison Electric Ill., New York	100	93	95
" " " " 1sts	—	103⅛	103½
Edison Electric Ill., Brooklyn	100	100	101
" " " Boston	100	112	115
" " " Chicago	100	145	150
" " " Philadelphia	100	117	125
Edison Electric Light of Europe	—	—	3
" Bonds	—	80	85
" Ore Milling	—	10	11
Fort Wayne Electric	—	4½	6½
General Electric Company	100	43	43¾
" " " deb. 5's	—	84½	85
Interior Conduit and Ins. Co	100	20	30
Mount Morris Electric	—	—	65
Westinghouse Consolidated	50	32	33
" " " pref.	50	48	49
Western Union Telegraph	—	86¾	86⅞
American Bell Telephone	—	174½	175

New Incorporations.

The Philadelphia Elevated Electric Railway Company, capital stock $42,000, has been formed to construct and operate an elevated electric railway in Philadelphia. W. N. Boyer, D. R. Russell and D. C. McKee are interested.

THE ABINGDON ELECTRIC COMPANY, Abingdon, Ill., capital stock $12,500, has been formed to maintain and operate a plant for the generation and sale of electricity. C. C. Travis, Annie J. Travis and C. D. Warner are the incorporators.

THE ATLANTIC TELEPHONE COMPANY, Jersey City, N. J., capital stock $250,000, has been formed to manufacture and sell electrical machinery, apparatus and appliances. H. Scrymser, H. W. Gray and E. S. Wallace, of New York, are the promoters.

THE ELECTRIC POWER COMPANY, Portland, Me., capital stock $500,000, has been formed to manufacture and deal in all kinds of electrical and mechanical appliances. E. A. Clark, C. T. Child, Boston, and E. C. Ramsdell, Cambridge, Mass., are the promoters.

THE SPEARFISH ELECTRIC LIGHT AND POWER COMPANY, Chicago, Ill., capital stock $50,000, has been formed to erect and operate an electric light and power plant and do a general manufacturing business. W. S. Corbin, J. M. Cameron and J. A. Griffin are the promoters.

THE COLUMBIAN ELECTRIC COMPANY, New York, capital stock $5,000, has been formed to manufacture and sell electrical

apparatus. J. C. Smith, 251 West 127th street; R. G. Vassar, 28 West 25th street, and Alexander Carmichael, 232 West 48th street, New York, are the promoters.

THE CARONA MARBLE COMPANY OF VERMONT, Brandon, Vt., capital stock $100,000, has been formed to supply electric lights, mine and quarry, etc. F. G. Swinington, Rutland; D. D. Hewitt, Brandon, Vt.; G. W. Quintad, D. C. Tate and John Yard, of New York, are the incorporators.

THE CHAGRIN FALLS ELECTRIC COMPANY, Chagrin Falls, Ohio, capital stock, $10,000, has been formed to furnish electric light and power, deal in electrical appliances, etc. J. W. Hutchinson, Wm. E. Guyant, G. H. Gifford, William Hutchings and E. I. Bailey are the promoters.

THE MENOMINEE POLICE AND FIRE ALARM COMPANY, Menominee, Mich., capital stock, $5,000, has been formed to manufacture and sell all kinds of mechanical and electrical devices for fire and police alarms, etc. H. Tideman, J. H. Kratz and Joseph Fleisham, of that town, are the interested parties.

THE LONG ISLAND ELECTRIC RAILWAY COMPANY, Freeport, N. Y., capital stock $600,000, has been formed to operate an electric railway. A. R. Hunt, 196 Hancock street, Brooklyn; C. M. Cooper, 320 Pearl street, New York, and Clarence Wolf, 506 Minor street, Philadelphia, Pa., are the incorporators.

THE BELLEFONTAINE LIGHT AND POWER COMPANY, Bellefontaine, Ohio, capital stock $25,000, has been formed to manufacture and furnish electricity for light, heat and power; to open street car lines, etc. Robert Colton, James Colton, C. H. Harner, F. J. McColloch, E. J. Hewenstine and W. C. Huston are the promoters.

THE WILLIAMS PUBLISHING AND ELECTRIC COMPANY, Cleveland, Ohio, capital stock $50,000, has been formed to supply electricity for various purposes, also steam power, and to conduct a printing plant. C. V. Hard, D. J. Hard, L. P. Ohliger, Louis Mandelbaum and Wm. M. Raynolds are the promoters.

THE IDAHO ELECTRIC RAILWAY AND POWER COMPANY, Boise City, Idaho, capital stock $2,000,000, has been formed to construct a standard gauge railway, to be run by electricity or steam, from Boise City to Lewiston, Idaho. The promoters are J. Bartlett Warren, F. C. Bond, G. M. Parsons and C. M. Day, Boise City, Idaho.

THE MOHNSVILLE AND ADAMSTOWN ELECTRIC RAILWAY COMPANY, Adamstown, Pa., capital stock $50,000, has been formed to construct and operate an electric railway in Berks and Lancaster counties. L. T. Custer, E. E. Billingsfelt, S. W. Miller, Adamstown; I. S. Spatz, Mohnsville, and V. S. Setzer, Reading, Pa., are interested.

THE CORTLAND ELECTRIC FIRE ALARM COMPANY, Toledo, Ohio, capital stock $100,000, has been formed to manufacture and deal in all kinds of electrical appliances, and to wire buildings and operate the Cortland fire alarm system, etc. H. Cortland, D. L. Boyce, J. G. Paine, C. W. Brokaw and E. B. Southard are the promoters.

PALMYRA, N. Y.—The Palmyra Electric Light Company has been organized with a paid up capital stock of $10,000. The following gentlemen were elected directors for the ensuing year: B. H. Davis, C. C. Hunt, George Tinklepaugh, Samuel P. Nichols, of Palmyra, and W. J. Morrison, of Syracuse, N. Y. At a meeting of the directors the following officers were elected: B. H. Davis, president; W. J. Morrison, vice president; S. P. Nichols, secretary and treasurer.

Special Correspondence.

New York Notes.

OFFICE OF THE ELECTRICAL WORLD,
41 Park Row NEW YORK, March 10, 1894.

L. J. WING & CO. have taken a five years' lease of the building 109 Liberty street, to which they will remove their business May 1.

THE NATIONAL WATER TUBE BOILER COMPANY, of New Brunswick, N. J., moves its New York office from 18 Cortlandt street to 74 Cortlandt street the latter part of this month.

MR. L. C. LANPHEAR, 50 Oliver street, Boston, Mass., Eastern representative for M. T. Davidson's pumps and hydraulic machinery, was in New York last week and reports business in the East booming.

G. H. ALMON, 136 Liberty street, New York, selling agent of the Belknap Motor Company, has just sold to the Bishop Gutta Percha Company two 10-kw. Belknap dynamos, one 10-h. p. Belknap motor, and one 3-h. p. Belknap motor to the News Printing Company, Rutland, Vt.

CARPENTER, HEWARD & CO. have opened a store at 289 Fourth avenue, New York, for the sale of electric and gas fixtures, fireplaces, mantels, etc., and architectural metal work. They will be the agents for the New Jersey Lamp and Bronze Company, of New Brunswick, and do a jobbing, supply and retail business.

MR. E. B. WILLCOX, proprietor of the Fulton Foundry and Machine Works, 21 Furman street, Brooklyn, N. Y., who, some months past was obliged, owing to illness, to close his works, has recovered his health and resumed operations in all departments.

New England Notes.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
Room 91, Hathaway Building, 620 Atlantic Ave.,
BOSTON, Mass., March 10, 1894.

MR. ELLIOTT O. JOHNSON has acquired the New England sole agency for the Boston Incandescent Lamp Company, in addition to representing Holmes, Booth & Haydens, with headquarters at 70 Pearl street, Boston.

LAWRENCE, MASS.—The City Council, through a committee, is investigating police signal systems preparatory to reporting on the advisability of placing one in the city. It is thought that it may cost $7,000 to install a complete system.

THE J. M. CARPENTER TAP AND DIE COMPANY, of Pawtucket, R. I., is introducing its new set of adjustable dies, adapted to electrical work and also for bicycle work, and finds already quite a demand for them. It reports business as generally very good, which is not at all surprising, as its specialties are of the best manufacture.

THE BOSTON ELECTRIC LIGHT COMPANY has made a reduction to the city for street lights to 35 cents per light per night. This reduction was made with the understanding that the city use 2,000 lights. The city will be able thus to secure a greater number of lights for the cost than heretofore, which was 40 cents per light per night.

THE GAMEWELL WINS.—A year or more ago the Gamewell company was sued by the Municipal Fire and Police Telegraph Company for alleged infringement of patents issued to one Cole for devices on signal boxes. At the hearing Thursday Judge Aldrich granted the petition of the Gamewell company, dismissing both cases, and ordering the Municipal company to pay costs.

MESSRS. McKENNEY & WATERBURY, 181 Franklin street, Boston, have been recently awarded the following contracts for gas and electric light fixtures: Insane Hospital, Augusta, Me.; new court house, Laconia, N. H.; Carter Building, Boston; First Unitarian Church, Medford, Mass.; Memorial School building, Greenwich, Conn.; the Webster Building, Gloucester, Mass., and also the magnificent Kennard Block, of Manchester, N. H., the largest and finest building in the State.

W. B. SOUTHGATE & CO. have just opened offices at 146 Franklin street, Boston, for the purpose of acting as manufacturers' agents and dealers in electrical supplies. Mr. Southgate was for a number of years connected with the Whitney Electrical Instrument Company, during which period he made hosts of friends, who wish him success in his new enterprise. He is a young man of business ability and integrity, and we understand his associates are of like character.

THE COMMITTEE ON MERCANTILE AFFAIRS of the Massachusetts Legislature gave its first hearing on March 7 on the petition of the Bell Telephone Company for an increase of capital stock from $20,000,000 to $50,000,000. Ex-Governor Long, counsel for the company, took up most of the time with an interesting account of the financial policy of the company, and showed conclusively why the new capital was needed, and why and where it was to be put if granted. The committee afterwards visited the company's buildings in Boston.

MR. LOUIS J. HIRT, who, as is well known, has been for a long period mechanical engineer of the West End Street Railway Company, of Boston, resigned his position March 1. Mr. Hirt identified himself with the West End Company very soon after it adopted electric traction, and did some excellent and valuable work. He is possessed of first-class abilities as a mechanical engineer, and has opened an office at 8 Oliver street for the purpose of pursuing his profession. Some of his recent inventions, in which the electrical fraternity will be interested, will be shortly placed upon the market.

NOTWITHSTANDING THE REMOVAL of various departments of the General Electric Company business to Schenectady, the Hathaway and New England buildings, of Boston, are continually securing new tenants. There are already some 30 or 40 companies, large and small, engineering and wiring, of analogous interests to electric lighting and power, located in them. The rentals are far below other office buildings, and the buildings afford every comfort and convenience, superior light, good management; everything, in fact, to make a person or corporation comfortable, and secure him convenience, health and economy besides.

Pittsburgh Notes.

Pittsburgh, March 8, 1894.

THE WESTINGHOUSE ELECTRIC AND MANUFACTURING COMPANY, of this city, has declared a quarterly dividend of 1¾ per cent., which is payable on April 2.

R. D. McGONIGLE, the treasurer of the Allegheny County Light Company, who has been indisposed for some time, returned to his office, in the Westinghouse Building, a few days ago.

THE CLAYTON ELECTRIC COMPANY, a small local concern engaged in the construction of electric fixtures, has made an assignment without preferences. The liabilities are not large, and will be covered by collectable assets. Trouble in making collections is the cause given for the assignment.

AT A RECENT meeting of the board of directors of the Allegheny County Light Company it was decided to extend the operation of the company's circuit to Hazelwood, a small suburban town of Pittsburg. Hazelwood has a population of about 10,000, and the company expects to add 1,500 lights to its capacity by next fall.

AT THE ANNUAL MEETING of the Allegheny Light Company the following board of directors was elected for the ensuing year: George Westinghouse, Jr., president; George H. Blaxter, vice president and general manager; H. H. Westinghouse, C. L. Magee, John E. Ridally, Wm. Eberhard, James H. Willock, Robert Pitcairn and William McConway.

THE PITTSBURG AND MANSFIELD STREET RAILWAY COMPANY, a corporation organized about six months ago for the purpose of constructing an electric road from this city to Mansfield by building a bridge across the Monongahela and piercing a tunnel through the hills on the south side of the river, has at last succeeded in obtaining the endorsement of the Pittsburgh mayor of its plan, who withdrew his opposition a few days since and signed an ordinance granting the company the franchise to build their road.

Western Notes.

Branch Office of The Electrical World
936 Monadnock Building Chicago March 9, 1894.

Mr. W. C. McKINLOCK, secretary of the Metropolitan Electric Company, reports business as being on the increase, having just returned from an extensive business trip with some good sized orders for the specialties handled by his company.

THE ELECTRIC APPLIANCE COMPANY, without making very much hurrah about it, has been quietly building up a very nice trade on the Acme tape, a specialty which it first placed on the market something over two years ago, and which has stood the test of time and made many friends.

Canadian Notes.

Ottawa, March 9, 1894

OTTAWA, ONT.—J. E. Chown, representing the Webster Electric Company, of Boston, who is in this city, purchased 75 tons of mica yesterday, the product of the mine at Perkins' Mills.

A SPECIAL GENERAL MEETING of the Ottawa Electric Light Company will be held March 19 to consider the proposed amalgamation of the company with other companies, etc.

AN ATTEMPT will be made at this session of the Dominion Parliament to give electric railways a status that they do not now enjoy under the General Railway act.

THE CITY CORPORATION is applying to the Legislature for power to manufacture and use and supply to others electricity for motive power and for any other purpose to which the same can be applied.

THE INCORPORATION of a company to construct and operate a bicycle electric railway from the city of Winnipeg, in Manitoba, to the port of Louisburg, in Cape Breton, is among the measures to come before the next session of the Dominion Parliament.

IT HAS BEEN definitely decided to establish government control over electric light meters, and a bill for this purpose will be put through Parliament this session. The electric light companies are in favor of government inspection, and the consumers will, no doubt, be glad of some protection.

THE PLANS for the amalgamation of all the electric light companies in Ottawa have been fully matured, and it has been decided to carry the important changes into effect on June 1. After that date the Chaudiere, Standard and Ottawa electric light companies will be under one management. No general manager has yet been appointed, but Mr. Berkeley Powell, at present manager of the Standard, is favorably spoken of for the position. It has been agreed between the promoters of the amalgamation not to increase the existing rates, but, if possible, to reduce them.

WINDSOR, ONT.—Application is being made to the Ontario Legislature to incorporate a railroad company with power to construct a railroad from the town of Amherstburg to the city of Windsor, and to equip and operate the same by steam, electricity or other motive power.

LONDON, ONT.—Application is being made to the Ontario Legislature for an act to incorporate the London and Springbank Electric Railway Company, with power to construct and operate an electric railway from the city of London to a point on the River Thames, near Springbank, and to construct a bridge over said river at or near Springbank.

PETERBORO, ONT.—The Canadian General Electric Company has secured a contract from the Toronto Street Railway Company for 80 street car motors and about 3,000 h. p. of generators. Including this contract, the Canadian General Electric Company has sold during the past few weeks electrical apparatus to the value of about a quarter of a million of dollars.

BRITISH COLUMBIA.—The bill to incorporate the Great Western Telegraph Company has been printed. The line is to run from Nanaimo to Vancouver, from Vancouver to New Westminster, and from New Westminster across the Fraser River to Brownsville. The incorporators are R. A. Anderson, H. V. Burner, John A. Fleet, W. H. Goodwin and Michael King, and the capital stock is $75,000, divided into $5 shares.

MONTREAL.—The directors of the Merchants' Telephone Company, at a special general meeting of shareholders held this week, were authorized to dispose of the balance of the capital stock of the company, amounting to about $20,000. The present shareholders, who were limited to $100 stock, will have the first chance of subscribing for the stock. Mr. F. X. Moisan, the president of the company, stated to-day that there was no intention of selling out to the Bell company, even should that company be disposed to buy.

English Notes.

(From our own Correspondent.)

London, Feb. 28, 1894.

THE FIVE-WIRE SYSTEM AT MANCHESTER.—The Manchester Electric Light Supply, which is on the five-wire system, is, I hear, by no means satisfactory, the pressure regulation leaving much to be desired, and the mains giving much trouble.

GAS ENGINES.—There is much discussion going on in the electrical papers in this country on the subject of the possibility of the parallel working of alternators driven by gas engines. One result of this discussion is to show that double acting gas engines are rapidly coming into favor. I understand that the well-known makers of steam engines, Messrs. Willans & Robinson, are shortly about to bring out a gas engine much on the same lines. I believe, as their splendid steam engine.

THE ELECTRICITY SUPPLY COMPANIES.—Judging by the dividends which have been announced within the last few days, the electricity business in this country is at last attaining a satisfactory stage. The Kensington and Knightsbridge company, which has some 64,000 lamps connected to its mains, has just paid a dividend of 5 per cent. for the year 1893, while the Westminster company, which has over 130,000 lamps connected, and the Chelsea company, which has about 45,000 lamps connected, have also both paid 5 per cent. dividends, while in Newcastle one of the electricity supply companies has scraped together sufficient profit to pay 5½ per cent. on its ordinary shares.

THE UTILIZATION OF TOWN REFUSE.—Owing to the high price of coal and other good fuels at the present time, the attention of electrical engineers has lately been directed to the utilization of dust bin refuse for raising steam for electric lighting. Among the municipalities which are paying some attention to this at the present time are St. Pancras, Shoreditch and Harrowgate, while a few days ago a party of representatives of the technical and general press visited Halifax, in Yorkshire, for the purpose of examining a new type of furnace and boiler, constructed under the patents of the late M. Livet. It is claimed that this furnace will evaporate from three to four pounds of water for every pound of refuse burned, without subjecting the refuse to previous desiccation, but so far as I could gather no official trials of this furnace either at full load or under actual working conditions have been made.

BOARD OF TRADE ELECTRIC TRACTION REGULATIONS.—An important conference between the Board of Trade and representatives of the interests involved in its electric traction regulations was held to-day, the sitting lasting from noon to 4 o'clock, the meeting being then adjourned until Friday. Everybody came armed cap-a-pie to fight the Board of Trade over Rule 14, which practically laid down that electric tramways were on no account to disturb telephone circuits. The impending fray was, however, warded off by the simple announcement on the part of the Board of Trade that they propose to make the rule read that electric traction people were to take "all reasonable precautions" to prevent the disturbance of telephone circuits. The procedure of the Board of Trade in connection with these electric traction regulations is much to be commended. The regulations were first of all published in draft, and criticism invited. Conferences were then held between the Board of Trade officials and each of the num-

erous interests concerned. Finally, the whole of the suggested alterations were considered to-day between the Board of Trade and representatives of the tramway, railway, gas, water and telephone companies.

News of the Week.

Telegraph and Telephone.

OCALA, FLA.—James Chambers and others have applied for a franchise for a telephone system.

EVART, MICH.—The village Council has granted C. E. Bell a franchise for ten years to build and maintain a telephone exchange.

HANOVER, PA.—The Hanover Telephone Company has been granted authority to erect poles and string wires in the streets of the borough of Hanover.

GAINESVILLE, GA.—The Gainesville Telephone Company, $10,000 capital, has been incorporated. Hon. Allen Candler, H. B. Smith and H. L. Richardson are interested.

NEWBURGH, N. Y.—Through the efforts of Dr. W. B. Snow, of Milton, in Ulster County, the West Shore Telephone Company has been organized to connect Newburgh and Kingston.

BELL TELEPHONE PATENTS.—In the Senate, on March 1, Senator Gray offered a resolution directing the committee on patents to investigate all facts connected with the application for, and the issuance of, the Berliner patent, now held by the Bell Telephone Company. The same resolution was presented in the House by Mr. Bunn, of North Carolina.

LIABILITY OF TELEPHONE COMPANY FOR INJURY FROM CHARGED WIRE.—Where a telephone company permits a wire liable to become charged from an electric wire to hang down on to the sidewalk it is bound to exercise such care as will guard the public against injury from it. (Ahern v. Oregon Tel. and Tel. Co., Supreme Court of Oregon, 35 Pac. Rep., 549).

LIABILITY FOR CONVERSION OF PROPERTY USED IN VIOLATION OF LAW.—A telephone company which cuts and carries away wires of an electric power company is liable for the conversion, though the telephone company had lawful authority to carry on its business and the power company was not authorized to use its wires as it did, and though the telephone company cut the wires in attempting to comply with a notice from the Board of Electrical Control. Where the servants of the telephone company were ordered to cut the wires from its fixtures, also cary away the wires, it is liable for the conversion. (Electric Power Co. v. Met. Tele. and Tele. Co., Supreme Court, General Term, First Dept., 27 N. Y., Supp. 93).

Electric Light and Power.

OGDEN, IOWA.—Ogden is considering electric lights.

MONTGOMERY, MINN.—Citizens are working for electric lights.

BETHANY, MO.—Bethany has voted to issue $30,000 in bonds for electric and water works.

MASILLON, OHIO.—The City Council is investigating the matter of an electric lighting plant.

WILLIAMSPORT, MD.—The matter of electric lights and a fire department are being agitated.

GREENVILLE, OHIO.—The Greenville Electric Light and Power Company is being organized.

JANESVILLE, WIS.—The Council is investigating the matter of a municipal electric lighting plant.

GRAND JUNCTION, IOWA.—The plan of putting in electric lights by private enterprise is being considered.

OCEAN GROVE, N. J.—About $10,000 will be expended at Ocean Grove this year for better lighting of the streets.

AGRICULTURAL COLLEGE, MICH.—President Gorton is working for an electric lighting plant for the college.

KUTZTOWN, PA.—An agent is now canvassing citizens in the matter of locating an electric street lighting plant here.

WYTHEVILLE, VA.—The City Council of Wytheville has decided to purchase an additional dynamo. Wm. Terry is mayor.

CALEDONIA, N. Y.—The matter of an electric lighting plant for the village of Caledonia will be submitted to taxpayers March 20.

BUFFALO, N.Y.—A committee of the Buffalo Board of Aldermen has recommended that an electric light plant be built at a cost of $100,000.

NIAGARA, N. Y.—The Schoelkopf Hydraulic Canal Company will put in an extensive plant to furnish electrical as well as hydraulic power.

SHELDON, ILL.—Residents of Sheldon will likely vote at the spring election in the matter of issuing bonds for an electric light plant.

WOODSTOWN, N. J.—The taxpayers will vote at the spring election in the matter of an electric lighting plant for Woodstown.

MONTCLAIR, N. J.—Paul Wilcox, of Montclair, N. J., has applied for right to operate a public and private incandescent electric light plant.

DEMOPOLIS, ALA.—Proposals for a franchise to erect and operate an electric light and water works plant will be received by the Council.

APPLETON, MINN.—The citizens will vote at the coming election on the proposed issue of $15,000 electric light and waterworks bonds.

GRIFFIN, GA.—The Council has empowered the finance committee to contract for a power house, to be of brick, 30x45 feet, for the electric light plant.

TALLAHASSEE, FLA.—An electric light plant will be purchased by the Georgia and Florida Investment Company to light the hotel. H. P. Simmons, manager.

PLAINFIELD, N. J.—The North Plainfield Electric Light Company proposes to build a plant at Greenbrook, from which it will supply electric light to Bound Brook.

MILWAUKEE, WIS.—The Wisconsin Electric Dynamo Company will increase its plant at Layton Park as soon as the weather permits. Peter Egelhoff is president.

APPLETON, WIS.—O'Keefe & Orbison are making plans for a new power house for the Appleton Edison Electric Company, and they have contracted for construction.

SKIPPACK, PA.—The Directors of the Poor will hold a meeting on the 30th of March to decide finally in the matter of introducing the electric light into the institution.

HAMILTON, ONT., CANADA.—The matter of a municipal electric light plant will soon come up for settlement. Mayor Stewart is making a report to submit to the Council.

OWATONNA, MINN.—The city Council of Owatonna has voted to put in an electric lighting plant, which is to be owned and run by the city, and which shall not cost more than $15,000.

JAMESTOWN, N. Y.—It is stated that George W. Sisson is endeavoring to establish a new electric lighting plant, and that capitalists from Dunkirk and Corry are back of the scheme.

ATHENS, GA.—The matter of a municipal electric light plant will soon be passed upon by Council. There is a division among taxpayers as to the advisability of erecting a municipal plant.

HAMILTON, OHIO.—Sealed proposals will be received to March 17 for the construction and equipment of an electric light plant, as per plans of Charles L. Cornell and J. J. McMackin, city clerk.

TIFFIN, OHIO.—Albert Brewer and W. H. Dore, of Tiffin, have formed an electric lighting company and put in the lowest bid for lighting the streets of the city, and will likely get the contract.

GLOUCESTER, MASS.—The committee on street lights are on a trip to near-by towns looking up the methods of electric lighting for comparison with the local plant, with the aim to improve the latter.

MARTIN'S FERRY, OHIO.—Complaint is made of the action of the water directors in purchasing an electric plant for the pumping works without advertising for bids. A town plant is desired.

BINGHAMTON, N. Y.—The old electric light plant on Noyes Island, which was bought from the General Electric Company by E. S. Hammond, Jr., has been burned. Loss $7,000 and insurance $5,000.

SPRINGFIELD, OHIO.—John Eisenmann, of 449 Arcade, Cleveland, Ohio, is making plans for wiring, heating, etc., the State Masonic Home. The building will be lighted by its own electric light plant.

CLEVELAND, OHIO.—L. H. Lindhorst will erect a four-story business building on Pearl street and Walton avenue, and the matter is being considered of placing an electric lighting plant in the basement.

DALLAS, TEX.—The city government asks for bids until April 2 for four 100-light arc dynamos, 300 double arc lamps, with the necessary line and station material to install the plant. Bryan T. Barry is mayor.

LOCKPORT, N. Y.—The Council has adopted a resolution of Alderman Lamson calling for a special election, at which taxpayers will vote in the matter of issuing $40,000 4 per cent. bonds for a municipal electric lighting plant.

MALDEN, MASS.—This city has approved the all-night electric service contract, with the proviso that should a municipal plant be constructed the contract can be voided by a three months' notice to the company.

VINCENNES, IND.—At the annual meeting of the Vincennes Electric Light and Power Company the following officers were elected: C. Bierhaus, president; H. W. Frund, secretary and manager, and L. Reiter, treasurer.

WASECA, MINN.—Edmund Sykes, of Minneapolis, has been awarded the contract for putting in a waterworks system for Waseca at $28,230, to include pump house, pumps and an engine for the electric lighting plant.

HAMBURG, N. Y.—The Hamburg Electric Light and Power Company threatens to withdraw and shut up its plant unless the price is advanced from $60 to $80 per lamp. The Council will be asked to take immediate action.

STAMFORD, CONN.—Gillespie Brothers, of Stamford, Conn., will build a four-story brick and iron building at Stamford, Conn., from plans of J. S. Bogardus, of Stamford, and they ask for estimates on an electric light plant.

NATIONAL HOME, WIS.—Sealed proposals will be received at the treasurer's office to 11 A. M., March 26, for supplying the home with electrical supplies (Edison system) for the quarter ending June 30, 1894. J. E. Armitage is treasurer.

ALEXANDRIA, VA.—A bill has been introduced to incorporate the Alexandria Light and Power Company, with offices in Alexandria. The incorporators are R. H. Phillips and H. H. Wells, of Alexandria, and James H. Embrey, of Washington, D. C.

NEW BRIGHTON, STATEN ISLAND, N. Y.—The trustees of New Brighton have received a communication from A. E. Leon, representing Boston capitalists who wish to light the village streets by electricity, and the matter is being considered.

MONTCLAIR, N. J.—The petition of Paul Wilcox and others for leave to establish an electric lighting plant will be considered at a special meeting March 19, in the evening. They ask for a 25-year franchise; plant to be in operation within six months.

PALMYRA, N. J.—There is a project being pushed by which Palmyra will have electric lights. The scheme is to purchase the plant of Beverly, making Riverside the central station and then run wires from that place to Riverton, Palmyra and Beverly.

ATHENS, GA.—The Athens "Banner" calls attention to the fact that there are but four months of the present lighting contract to run, and that steps should be taken now or never in the matter of issuing bonds to pay for a municipal electric lighting plant.

HONESDALE, PA.—A project is being formed for the erection of an electric lighting plant on Wallenpaulack Creek, near Hawley. The company is to be known as the Delaware and Hudson Electric Motor Company, and it proposes to propel boats by electricity.

SOMERSWORTH, N. H.—The Consolidated Light and Power Company has been permitted to issue receiver's certificates to the amount of $5,500, of which $2,500 is for back pay and the balance for improvement to the plant, in order that better light may be furnished.

ERIE, PA.—The city clerk has been directed to call for proposals for lighting the streets of Erie with gas, electricity or other illuminator, proposals to be received to March 23. The Erie Telephone Company has been granted a franchise to operate a telephone system here.

MAMARONECK, N. Y.—The Larchmont Electric Lighting Company, which will establish a plant at Mamaroneck, will be ready for operation May 1. The alternating system will be used. A one story brick building will be erected, with a dynamo room 50 by 50 feet, and a boiler room 30 by 45 feet.

WASHINGTON, D. C.—Sealed proposals will be received to 2 P. M. March 14, at the Treasury Department, for manufacturing and placing in position at the United States Building at Springfield, Mo., combination gas and electric light fixtures, as per specifications, on application to S. Wike, acting secretary.

HINGHAM, MASS.—The committee on a municipal electric light plant has recommended that a temporary contract be made for electric lighting, and that as soon as experience is gained the city establish and operate a plant. Fred. M. Hersey, Eben I. Ripley, C. Sumner Cushing and George W. Burr are the committee.

GORHAM, N. H.—The Gorham "Mountaineer" is authority for the statement that the Grand Trunk Railway of Canada, with head office at Montreal, Canada, will install an electric lighting plant at their works; that they have offered to put light in the streets of Gorham, and that the committee on light has the offer under consideration.

HIGGINSVILLE, MO.—Bids were received by the city on Feb. 27, 1894, for the construction of a complete electric light plant for the city. There were bids from all principal companies now doing business. The Council finally adopted the Westinghouse system, and awarded the construction to the Franklin Electric Company, of Kansas City, Mo.

KINGSTON, N. Y.—On motion of Alderman Lang, the Common Council decided to take into consideration the advisability of building its own electric light plant, and the mayor states that he will appoint a committee of three to investigate and report. Alderman Block has been informed that the desired plant can be built for about $40,000.

READING, PA.—On April 12, at 2 P. M., the stockholders of the Reading Electric Light and Power Company will vote in the matter of leasing its property to the Metropolitan Electric Company, and, at the same time, the Metropolitan Electric Company will vote in the matter of leasing the said lines of the Reading Electric Light and Power Company.

The Electric Railway.

NORFOLK, VA.—The Norfolk City Railroad has been granted permission to extend its tracks.

CLEVELAND, OHIO.—A project is being considered for the extension of the lines of the Cleveland and Berea street railway.

NEW BEDFORD, MASS.—It is reported that the Union Street Railway Company will soon equip the Purchase street line with electricity.

MINNEAPOLIS, MINN.—There is a prospect that the St. Louis Park electric line will be extended to Hokins this summer, a distance of two miles. T. B. Walker is owner.

RICHMOND, VA.—A bill has been introduced into the Legislature to incorporate the Southern Railway and Electric Company, to build an electric line from Richmond to the Potomac River.

BALTIMORE, MD.—The order has been signed granting a six months' extension for the work of beginning the construction of the Baltimore, Middle River and Sparrow's Point Railway Company.

HOMESTEAD, PA.—The Homestead Street Railway Company has accepted the franchise giving it right of way over Eleventh avenue, and will begin work at once, and hopes to finish in three months.

OLYPHANT, PA.—An ordinance has been passed granting additional right of way to the Olyphant Suburban Traction Company to lay tracks, erect poles and string wires in the streets of the borough of Olyphant.

MARION, IND.—The Marion Street Railway Company, which now operates a line between Marion, Jonesboro and Gas City, will extend its line to Fairmont, six miles south, as soon as the weather will permit work.

READING, PA.—It has been decided to begin at once the extension of the Reading and Southwestern electric road to Adamstown, ten miles southwest, and a call of 10 per cent. has been made on the capital stock.

HARRISBURG, PA.—The Philadelphia Electric Elevated Railway has been chartered. The directors are Walter N. Boyer, Radcliff B. Mills, John R. Rowman, Samuel R. Russell and David McKee, all of Philadelphia.

NORTHAMPTON, MASS.—The Northampton Street Railway directors have asked for permission to increase their capital stock from $150,000 to $300,000, that they may build an 8-mile extension from this city to Williamsburg.

JOHNSTOWN, N. Y.—Lawton Caton, of Gloversville, N. Y., so states the Johnstown "Republican," has announced that the proposed electric line between Akin, Johnstown and Gloversville will be built during the coming summer.

HAMILTON, ONT.—The Hamilton Radial Electric Street Railway Company asks for permission to increase its capital stock from $1,000,000 to $2,000,000, and to extend its lines to Niagara Falls, Brantford, Queenston and other points.

THE ALDERMANIC COMMITTEE on railroads will, on April 5, hear the application of the Third Avenue Railroad Company for permission to extend its lines up St. Nicholas avenue, New York. The committee is opposed to the trolley system.

DE PERE, WIS.—The Green Bay Electric Street Railway Company will petition for a franchise to enter the town of De Pere. Should the franchise be granted, tracks will be laid through the town of Allouez, between Green Bay and De Pere.

PHILADELPHIA, PA.—H. M. Hoyt, of Philadelphia, gives notice that on March 26 he will apply to Governor Pattison for a charter for the Berks and Dauphin Traction Company, one of the companies organized by the Penn Traction Company.

COLUMBIA, S. C.—It is stated that the Columbia Electric Street Railway Company and the Columbia Land and Investment Company propose to extend the electric line to a suburban town to be established just beyond the southeastern limits of the city.

BOSTON, MASS.—The committee on street railways will give a hearing March 5 at 10 A. M. at the State House on the petition of the Boston and Revere Electric Street Railway Company to lease its franchise and property to the Lynn and Boston Railroad.

PHOENIXVILLE, PA.—Colonel Du Pont, of the Delaware River and Chester Railroad, states that they will experiment with the trolley system for that portion of the line between Phoenixville and Falls of French Creek, and that in the spring they will build many extensions.

WATERBURY, CONN.—C. W. V. Blakeslee & Sons have contracted to build the tracks for the Waterbury electric road, and they will begin work as soon as the weather permits. There are six and a half miles of tracks, and the contract will amount to about $25,000.

ALBION, N. Y.—At a meeting recently held, the following were appointed a committee to consider the proposition of Emmons, Dwyer & Co., of Syracuse, to build a road from Batavia to the

lake: Wm. Hallock, Henry Blood, George W. Potter, E. L. Wage and D. S. Beckwith.

WASHINGTON, D. C.—The House District committee has adjourned without taking action in the matter of the application for a franchise of the Washington and Georgetown Terminal Railway Company, of which Andrew B. Duvall, E. Kurtz Johnson and E. Southard Parker are directors.

HARTFORD, CONN.—At a meeting held in the office of M. S. Chapman, of the Government Envelope Agency, it was decided to open for subscriptions the books of the Hartford, Manchester and Rockville Tramway Company. It is the intention to extend as far as Manchester during the coming summer.

ANNAPOLIS, MD.—The hearing in the matter of the application of the City and Suburban Railway Company for a double track electric railway from Baltimore to Catonsville has been postponed. Nelson Perin is president of the company, Frank H. Sloan is engineer and G. D. Penniman is counsel.

WASHINGTON, D. C.—Mr. McKaig, of Maryland, has introduced a bill into the House to incorporate the Washington, Burnt Hills and Sandy Spring Railway Company to build a road to be operated either by electricity or cable between these points. Geo. W. Cissel, Ralph L. Galt, Charles G. Stone and George W. Harvey are interested.

SPRINGFIELD, MASS.—A public hearing will be given March 12 on petition of the United Electric Light Company for permission to place additional wires. A hearing will be given April 2 on petition of Henry S. Dickinson, George S. Taylor and George Nye, representing the Wymanlea Street Railway Company, for location for its tracks.

SPRINGFIELD, MASS.—Charles H. Hall, the well-known real estate operator, of Belmont avenue, is getting up a $200,000 company to build an electric line to East Longmeadow and Hampden. The following residents of Springfield also are interested: Chauncey Morrill, D. M. Butterworth, Hitchcock & Co., Gowdy & Remington and E. M. Lombard.

PHILADELPHIA, PA.—The Brigantine Transit Company, of Brigantine, N. J., has contracted with Stern & Silverman, of Philadelphia, for the reconstruction of its entire road, built a year ago. The line is to be constructed on trestles, with a considerable amount of bulkheads and jetties projecting into the ocean. The road will be in operation June 1.

CINCINNATI, OHIO.—Plans are almost completed and bids will be asked in a few days for the proposed new power house for the Mount Adam and Eden Park Electric Railway Company, to be erected on Gilbert avenue, which is to have four boilers, two 800-h. p. engines and four 400-h. p. generators. Bert L. Baldwin, 227 Main street, engineer.

ST. AUGUSTINE, FLA.—The St. Louis Engineering Company has agreed to give $100,000 to build an electric road from North Beach to Moultrie, provided $25,000 is raised in St. Augustine. Captain Adolphus Pacetti has offered to give $5,000 of the amount. It is understood that the promoters of the St. Augustine Electric Railway hold an option on the charter of the North Beach Railway.

CORNING, N. Y.—F. D. Kingsbury inserts an advertisement in the Corning "Democrat," stating that he has secured control of the charter and franchises of the Citizens' Railway Company, and that he will undertake the work of reorganizing the company, provided citizens will aid. He proposes, as soon as possible, to build a first-class street railway between here and Painted Post. He will personally subscribe one-tenth or more of the necessary funds.

LANCASTER, OHIO.—The stockholders of the Lancaster Street Railroad Company have elected the following officers: Wm. Duffy, president; Dr. G. Mussee, vice president; C. F. Nestor, secretary, and A. Bauman, treasurer and manager. It is the intention, as early as possible, to equip the road with electric cars, when an attempt will be made to extend the line to the Boys' Industrial Home, six miles distant, making a 10-mile road, as was originally intended.

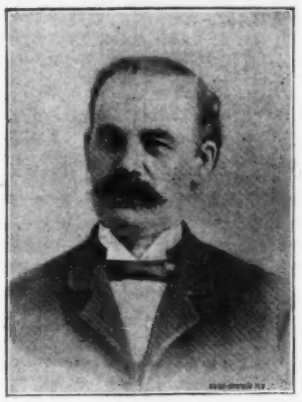
GEORGETOWN, NEAR WASHINGTON, D. C.—The Washington "Star" is authority for the statement that the Metropolitan Railroad Company is considering the question of connecting its line with the various suburban electric lines about Georgetown, and that as soon as the existing question of introducing a new power on their road is settled application will be made at once for the necessary permission. The project of electric lines will also be considered in the application.

FAIRPORT, QUEENS COUNTY, N. Y.—The Long Island Electric Railway Company has been incorporated at Albany, with principal office at Fairport. It proposes to operate a 20-mile road between Hempstead and the intersection of Liberty and the city line of Brooklyn. The capital stock is $600,000, and the directors are Alexander R. Hart, of Brooklyn; Charles H. Mullin, Mount Holly Springs, Pa.; Charles H. Cooper, William H. English, George W. Miliar, of New York, and Clarence, Benjamin and Edward Wolf, of Philadelphia, Pa.

CENTREVILLE, MD.—Steps are being taken for an electric railway to connect Centreville, Churchville, Chestertown, Queenstown, and other cities in the peninsula. W. H. Bosley, of Baltimore, accompanied by a surveyor, has surveyed the proposed route. The capital stock of the company will be $500,000, and the incorporators are Congressman John B. Brown, W. W. Busteed and Wilmer Emory, of Centreville, and ex-Mayor Robert C. Davidson, Bartlett S. Johnson and William H. Bosley, of Baltimore. The principal office will be in Centreville.

Personal Notes.

MR. GEORGE F. PAGE, who has been the prime mover in developing the Concord Land and Water Power Company, and until Jan. 1 its president, was born at Pittsfield, N. H., in 1844. He was educated in the Franklin Academy and Eastman's Business College, Poughkeepsie, N. Y., in the meantime learning the tanner's trade. Immediately after completing his studies he went to Europe and served an apprenticeship to perfect himself in the business of leather making, and on his return to this country he mastered the trade of belt making. He then formed a partnership with his brother, C. T. Page, and under the name of Page Brothers they started in 1868, at Manchester, the business now conducted under the name of the Page Belting Company, that enjoys almost world-wide reputation. Mr. Page has earned a reputation in the Legislature of New Hampshire, one of his great successes being the passage of a law establishing the Australian ballot system.



MR. E. F. CARPENTER, the general superintendent of the company, was born in Rowe, Mass. He early developed an interest in electrical matters. He was left an orphan at 13, and worked for two years in a saw mill, and then went to Fitchburg, Mass., where he learned the machinist's trade. He was made foreman of the shop while an apprentice, and gained a large experience in steam boilers and engines and in the construction of dynamos. He obtained instruction in mechanical engineering drafting at the Fitchburgh night schools. After completing his apprenticeship he worked at his trade through Pennsylvania and Ohio to Illinois. He then joined the Thomson-Houston Company at Lynn, Mass. He afterwards became assistant electrician of the Loomis Electrical Company, constructing a plant at Gardner, Mass. He held the position of superintendent and manager for nearly three years. He invented an ironclad armature, selling the patent to the Wenstrom Company of Baltimore. He then became electrical engineer for the town of Melrose, designing a large municipal plant there. Next he connected himself with the Edison General Electric Company. In January, 1892, he joined the Concord company, where he brought himself into notice by constructing an entire arc light plant of 100 lights capacity, including line, etc., within 30 days. He is now general superintendent of the company, which has obtained control of all its rivals in Concord.

MR. H. J. ODELL, the treasurer of the company, was born at Franklin, N. H., and it was in that town that he first engaged in the retail clothing and drygoods business. His commercial interests brought him in contact with the general agent and manager of the Franklin Woolen Company, who was impressed with his business capacity, and invited him to join the force of that concern. Mr. Odell was rapidly promoted, and soon gained a position of responsibility with that company. He is president of the Franklin Needle Company, and has established a reputation for integrity and energy which made his selection as treasurer of the Concord Land and Water Power Company a most natural one.

JONAS WENSTROM, inventor of the Wenstrom system of dynamos and motors, died at Westeras, Sweden, on Dec. 21, 1893.

Miscellaneous Notes.

WILLIAM MAVER, JR., delivered a lecture on "Telegraphy" on March 5 at Cooper Union, being one of the University extension course of lectures.

THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY has issued its annual report and catalogue, which show that the course in electrical engineering is more largely attended than any other of the thirteen courses taught; those in mechanical and civil engineering following in the order named. The number of students in electrical engineering for each year from 1884 to 1893 is given as follows: 30, 41, 52, 61, 74, 91, 105, 108, 112, 141.

A MUNICIPAL PLANT.—A committee of the Jamestown, N. Y., Council, in a report on the city municipal lighting plant, states that the superintendent, Mr. Maloney, paid the son of Alderman O'Connell for 22 hours of work a day, and when the latter was sick hired a substitute to whom he paid $35 per month, but charged the city $55. Other peculiarities of Mr. Maloney's administration are cited, all of which, however, were excused by Alderman O'Connell on the plea that the superintendent "had been careless in his figuring."

INGRATITUDE.—An injunction has been granted by Judge McConnell, of Chicago, requiring the Siemens-Halske Company to continue furnishing current to Larry McGann's Twenty-second street railway. The company claims that to accomodate Mr. McGann and enable him to hold his franchise it consented to furnish him from 60 to 90 h. p. of current from its factory temporarily for cost. At an extra expense they acceded to Mr. McGann's request to run at night and on Sundays, and were much crippled when it was found that instead of 90 h. p. 900 were required. When a bill was sent in payment was refused and the injunction procured compelling the company to continue furnishing power.

MR. W. J. HAMMER delivered a lecture before the Dryden Literary and Musical Society, of Newark, N. J., on March 17 on "Electricity." The lecture consisted of an elaborate series of experiments in electricity, magnetism and in the appliances of electricity to lighting, power, telegraphy, telephony, war purposes, ballooning, electric heating and cooking, storage of electricity, etc., etc. Some interesting experiments in radiant matter were also shown, and the large stage was filled with an extensive collection of interesting apparatus, which was used in the lecture. Large diagrams were hung on the walls to illustrate the apparatus referred to. Mr. Frank Lawton and Mr. E. J. Cabot assisted.

THE NEW YORK ELECTRICAL SOCIETY.—A lecture on "The Electric Lighting of the World's Fair" will be delivered by Mr. Thomas Commerford Martin at Columbia College on Thursday, March 15, at 8 P. M. The lecture will be profusely illustrated by lantern. In the collection of data and slides Mr. Martin has had the active assistance of Mr. Luther Stieringer, who was the consulting electrical engineer of the Fair. Special attention will be given to night views of the Fair, exhibiting a wonderful advance in the photography of scenery and scenic effects after dark, and exemplifying the beauty of the electric light for spectacular purposes. Among the many points of interest to be treated in this original manner will be: The Electricity Building, the Tower of Light, Scenic Theatre, the dome of the Horticultural Building, the lagoons, Manufactures Building, the big search light, the Fine Arts Building, Administration Building, the Grand Court of Honor, the Stieringer electric fountains, effects produced by electric illuminations, etc., etc. The scenes will be shown in contrast of daylight and night effect.

Trade and Industrial Notes

STERN & SILVERMAN, 707 Arch street, Philadelphia, have had adopted by the Electric Traction Company of Philadelphia, which controls over 100 miles of electric railway, their method of bonding, using the Stern & Silverman bonding chuck.

THE BRYANT ELECTRIC COMPANY, through its Western representatives, Thomas G. and Edward R. Grier, Monadnock Building, Chicago, has issued a circular in compact form calling attention to the standard Bryant electric light fittings.

MR. J. J. RYAN, for six years connected with the Thomson-Houston Company, and later agent of the General Electric Company, in Cincinnati, has taken charge of the office of the Fort Wayne Electric Company, at 208 Neave Building, Cincinnati.

THE MASON REGULATOR COMPANY, 10 Central street, Boston, will send a box of the Columbian dominoes, which were in such great demand at the National Electric Light Convention, upon receipt of 12 cents, to prepay the cost of postage and packing.

THE SWITCH EXHIBIT of the W. S. Hill Electric Company that was admired by all at the convention recently held in Washington is now at the office of their representative, the Elson & Brewster Engineering Company, 141 Liberty street, New York, where it is attracting a great deal of attention. The new lightning arrester is causing much favorable comment.

THE AMERICAN FUEL ECONOMIZER AND ENGINEERING COMPANY, 136 Liberty street, New York, has issued a handsome and well illustrated catalogue thoroughly describing the American fuel economizer. The pamphlet contains considerable engineering data of importance, and many hints may be gotten from the plans of arrangements of boilers and economizers shown.

THE GRAPHITE LUBRICATING COMPANY, Bound Brook, N. J., has issued a neat 36-page catalogue relating to its graphite and bronze bushings. It will repay any one to send for a copy of this pamphlet and read the testimonials of some of the leading manufacturers of the country, who have become converted to what was even recently considered a mechanical heresy—the use of dry bearings.

THE INDIA RUBBER COMB COMPANY, 9 and 11 Mercer street, New York, sole agents for the sale of Chicago electric wire, is in receipt of a letter from Mr. W. L. Pomeroy, president of the Brush Electric Illuminating Company, of New York, in which he says: "We have been using, since 1889, rubber insulated cable manufactured by the Chicago Electric Wire Company, and it has given us entire satisfaction in every respect."

MR. NATHAN DURFEE AND MR. T. W. SPRAGUE, who, for three or four years past, have been connected with the Thomson-Houston Motor Company, and later with the power and mining departments of the General Electric Company, moving with the latter to New York and Schenectady, have returned to Boston to accept positions with the engineering firm of Westinghouse, Church, Kerr & Co., with headquarters at 620 Atlantic avenue.

THE CENTRAL ELECTRIC COMPANY, Chicago, reports a larger demand for the new iron armored interior conduit, which has been brought out to meet the requirements of a higher grade of construction. Their first order was given by Mr. C. W. Furbeck, 1161 Monadnock Building, who will use it for the wiring of the new west side tunnel. The presence of a large amount of moisture renders the use of a high insulating medium imperative, and this new type of conduit meets all of the exacting requirements.

CHARLES A. SCHIEREN & CO., 45 Ferry street, New York, have recently received an order for a 72-inch three-ply electric belt from the Kearney Cotton Mill, Kearney, Neb. They find that the idea of the perforations is meeting with more favor day by day as people find practical results emanating from them and the satisfaction that the perforated belts give. They pride themselves on keeping up the quality of their electric belting, and intend it shall be the very best belting that can possibly be made under any circumstances for electrical machinery.

THE BERLIN IRON BRIDGE COMPANY, East Berlin, Conn., has just received an order from the New Jersey Zinc and Iron Company, at Newark, N. J., for the iron roofs on its buildings. The furnace room will be 50 feet wide and 400 feet long, made entirely of brick and iron. The engine room, fan room and boiler room will be 60 feet wide and 187 feet long, the engine room covered with slate and the fan room and boiler room covered with corrugated iron. Also an order from the Philadelphia Gas Improvement Company for an iron roof for its new coal sheds.

THE BALL ENGINE COMPANY, Erie, Pa., has recently received orders for the following engines for public buildings in different parts of the country: Two 100-h. p. engines to the Criminal Court Building, Chicago; one 100-h. p. engine to the House of Correction, Chicago; one 60-h. p. engine to the Illinois State Reformatory, Pontiac, Ill.; one 100-h. p. engine to the Industrial Home for the Blind, Chicago; two 100-h. p. engines to the State Asylum for Chronic Insane, Wernersville, Pa.; one 135-h. p. engine to the Willard State Hospital, Willard, N. Y.

THE OHIO BRASS COMPANY, Mansfield, Ohio, has issued a handsome catalogue (No. 2) of its manufactures of electric street railway supplies, consisting of construction material, line devices and car appliances. Attention is called to the fact that all of the devices are thoroughly tested for electrical and mechanical defects and approved by the engineeering department before being sent out. Although the Ohio Brass Company has not until recently dealt directly with the electrical trade in general, it had been manufacturing construction material for several years for one of the largest supply houses in the West, and its products are now in use on many of the largest roads in the country. The catalogue contains 84 pages, is handsomely illustrated, and should be in the hands of all dealers and users of street railway material.

THE HINE & ROBERTSON COMPANY, 57 Cortlandt street, New York, is having much success with its Union semi-metallic packing, made from a fine quality of imported asbestos cord, braided together in layers, and well lubricated during the process of braiding. Each asbestos braiding is closelycovered with a abraiding of fine metallic wire, producing an article which is claimed to be a most important improvement in piston rod packings. It is designed for all purposes where packing is employed, but is more especially valuable where a high pressure of steam is used, as the most intense heat has no effect on it. For some months past it has

been tested by experts in one of the most prominent departments of the United States government, as well as in many other places, where pressures varying from 125 to 160 pounds are used, with most gratifying results.

THE WHITNEY ELECTRICAL INSTRUMENT COMPANY has given up its Boston office, and its business will hereafter be conducted at its factory at Penacook, N. H. A reorganization of the company has been effected as follows: Hon. D. B. Varney, president; F. T. Dunlap, vice president; D. H. Young, treasurer; O. B. Green, secretary; E. R. Whitney, financial manager, all of whom are well known New Hampshire capitalists; Dr. A. H. Hoyt, electrician, and Henry F. Kellogg, general selling agent. Mr. James F. Preston, its former treasurer and general manager, still retains an interest in the company, but will take no active part in its business conduct, which will be a source of regret to all who have had business dealings with him, as he is the embodiment of courtesy and kindliness. The present successful condition of the company is largely due to his energy and well directed efforts. The company is to be congratulated that it retains the services of genial Henry F. Kellogg as general selling agent, who is popular with the trade generally and possessed of exceptional abilities.

M. T. DAVIDSON, 77 Liberty street, New York, is much pleased with the praise received for the working exhibit of Davidson pumps at the World's Fair, which aggregated a pumping capacity of 5,000 h. p., and received an award. M. J. Dodds, operating engineer of the N. W. T. B. Co., in a recent letter says: "For many years I was led to believe that single acting pumps were not as reliable as boiler feed pumps. I am satisfied now that I was wrong. In the World's Fair Machinery Hall boiler house I had two of your make to feed our boilers (National water tube boilers of 1,500 h. p.) from March, 1893, to January, 1894, and I must say I was surprised with the regularity of feed, the water often registering 210 degrees Fahrenheit. I did not have the least trouble, something I cannot say for the injectors, which I never used except when compelled to do so. For your pumps in the future I shall always have a good word, because having seen all the different types of pumps in operation before, during and after the Exposition, I prefer yours to all of them."

THE PHILLIPS INSULATED WIRE COMPANY, of Pawtucket, R. I., is now located in its factory at Darlington, just on the outskirts of Pawtucket, and actively engaged again in the manufacture of its well known wire specialties. Its new factory is imposing and handsome, is built of brick with granite trimmings, and is 186 feet by 50 feet, with three stories and a basement. It is solidly built throughout, with a view of enabling the floors to bear the weight of the heaviest machinery, and its large amount of window space affords abundance of light and cheerfulness. It occupies, all told, 36,000 square feet of floor space. Its power plant consists of a 100-h. p. horizontal tubular boiler, from the Bigelow Works, New Haven, and a 60-h. p. Green engine, built by the Providence Steam Engine Company. Ample space is left in the power house for the addition of another 100-h. p. boiler, should occasion arise for additional power. It possesses also an electric plant capable of generating power for 200 incandescent lights. Particular attention has been given to the steam heating of the building, also to the system of sprinkling, the building being thoroughly equipped with the Newton automatic fire extinguisher. Its plumbing, it is said, cannot be surpassed in any building erected for manufacturing purposes. The offices are in the northeast corner of the building, and tastefully fitted up, and in thorough keeping with the brightness of the countenances of Treasurer H. O. Phillips and Secretary F. L. Smith over their new homes and their happy anticipations for a successful future. Considerable land is held in reserve for the growth of its business. The location of the factory is on the East Providence branch of the New Haven road, near the Darlington station, and the best of freight facilities is afforded.

MR. W. L. FAIRCHILD, 521 Kirk Building, Syracuse, N. Y., has recently received the appointment of electrical engineer for the city of Jamestown, N. Y., which is going to expend over $30,000 in betterments on its electrical plant, and has also been appointed engineer for D. McCarthy & Co., of Syracuse, who are going to build a block and will install a very large electric light plant. Mr. Fairchild has had experience in the electrical business for a number of years, and has recently started out in this branch on his own account, with flattering prospects of success.

THE ELECTRICAL APPLIANCE COMPANY, of Chicago, is one of the firms that bear evidence of the rapid development of electrical interests in the West. Their headquarters at 242 Madison street are most complete in arrangements for handling large quantities of supplies with great facility, and their line of specialties has always been considered standard. Visitors to the World's Fair will remember the exhibit of this house as one of the most attractive in the Electricity Building, where their display of "O. K." and "Paranite" wires and cables was handsomely set off by an artistic illuminated sign of "Packard" lamps flashing in various colors. During the Fair, and since, they have been very busy with orders, notwithstanding the general business depression, and they are now regarded as one of the first supply houses of the West.

Business Notice.

BATTERY CUT-OUT, CHEAP.—Sensitive, reliable, never requires attention. Gas lighting much improved by its use. Electric Supply Company, of 105 South Warren street, Syracuse, N. Y.

Illustrated Record of Electrical Patents.

U. S. PATENTS ISSUED FEB. 27, 1894.

(In charge of W. A. Rosenbaum, 177 Times Building, New York.)

515,321. INSULATING THIMBLE; I. A. Brown, Toledo, Ohio. Application filed April 5, 1893. An insulating thimble having its closed end increased in thickness, reduced in size near its open end and increased in thickness at or near its open end.

515,333. METHOD OF PEROXIDIZING LEAD; W. W. Griscom, Haverford, Pa. Application filed July 17, 1893. An electrolyte comprising water, sulphuric acid and nitric acid, in which the ratio of sulphuric to nitric is more than three to one.

515,342. ELECTRIC ARC LAMP; G. Kirkegaard, Brooklyn, N. Y. Application filed June 19, 1893. This comprises a frame pivoted at or near its upper end, and carrying a clockwork located below the pivotal point, in combination with an electromagnet acting upon the frame to swing on its pivot. (See illustration.)

515,366. ELECTRICAL RAILWAY SIGNAL; H. V. Riley and C. Selden, Baltimore, Md. Application filed Oct. 5, 1893. A differentially wound polarized relay, so wound that when the circuit is closed through both windings during the same interval of time the operation of the magnet will cause its local points to assume a certain position.

515,374. ELECTRICAL CONTROLLER; E. A. Sperry, Cleveland, Ohio. Application filed Aug. 23, 1893. In a controller, a cover provided with a slot for the operating handle, an apron overhanging the slot, and a handle protruding upward within the slot.

515,386. DYNAMO ELECTRIC MACHINE. J. Wenstrom, Orebro, Sweden. Application filed March 6, 1893. In a dynamo electric machine, the combination of the two poles with a field magnet, of an armature attached to one of the poles and having a continuous uninterrupted surface adjacent to the air gap, and a keeper of solid magnetic material, revolving in the air gap between the armature and the other pole.

515397. ELECTRIC GAS LIGHTER; J. O. Dahlgren, Boston, Mass. Application filed Dec. 30, 1893. The combination of a gas cock having attached to it an electrode and a spring pressed lever attached to a projection on the plug and carrying in one end an insulated electrode and in the other a pivoted pawl.

515,401. ELECTRIC HEATER; A. S. Hatch, Windsor, Canada. Application filed March 27, 1893. This comprises a face plate having an open base and an apertured upper portion, a series of open, rectangular insulated frames arranged one above the other and out of contact, and a heat developing conductor wound spirally around the frames.

515,420. WIRE COUPLING; D. A. Byers, Denver, Col. Application filed March 13, 1893. A coupling composed of an integral open ended tube enlarged interiorly and a detachable plate covering an opening leading to the central chamber.

515,432. PRIMARY BATTERY; C. J. Hubbell, Boston, Mass. Application filed May 31, 1893. This comprises a zinc element having a stud of metal projecting centrally from it and adapted to extend downward into a mercury cup; with the mercury cup connected electrically to one of the binding posts of the cell.

515,448. FIXING ELECTRIC CONDUCTING WIRES TO INSULATORS SUPPORTING THE SAME; R. Shomburg, Berlin, Germany. Application filed March 29, 1893. An insulator carrying a clamping device and means for operating the clamp, consisting of a bolt passing through the insulator and having eccentric discs at its ends.

515,465. ELECTRICAL GLOW LAMP; H. Cottrell, Newark, N. J. Application filed March 30, 1893. An exhausted bulb having a single conductor only, and a single conductive coating in electrical connection with such conductor through the source of current.

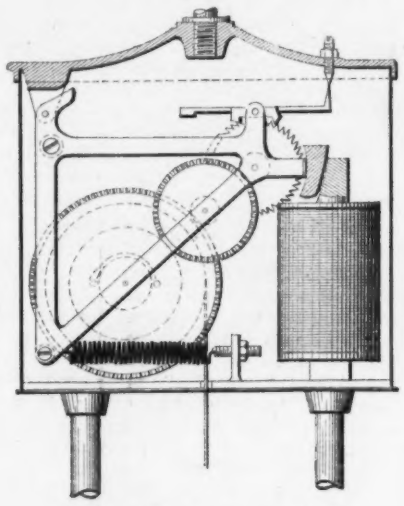
515,467. ARMATURE FOR ELECTRIC MACHINES; W. Fritsche, Berlin, Germany. Application filed July 11, 1893. This comprises a hub, a core built up of a series of interspaced elements arranged radially on the hub, and conductors contained in the spaces between the elements and arranged parallel with the longitudinal axis of the core. (See illustration.)

515,473. REGULATOR FOR CONTINUOUS CURRENT ARC LIGHT CIRCUITS; D. Higham, Boston, Mass. Application filed May 14, 1892. This comprises an electromagnetic device corresponding to wave variations of current, and acting to stable the main or generated current, combined with a second device responding slowly to variations of mean intensity of current and acting to regulate the main or generated current.

515,478. BOND FOR ELECTRIC RAILWAYS; J. Meyer, New York, N. Y. Application filed Oct. 21, 1893. The combination with the end rails of metallic plates located below the rails and provided with downwardly extending lugs and bonds connecting the lugs.

515,484. SOCKET FOR INCANDESCENT LAMPS; L. Stirn, New York, N. Y. Application filed June 22, 1892. A socket containing a shaft with a ratchet wheel and carrying a spring actuated pawl lever, to which a cord is connected, and a check pawl engaging the ratchet wheel.

515,485. LAMP SOCKET; L. Stirn, New York, N. Y. Application filed Nov. 18, 1892. The combination with a disc of two screws on the upper surface of the same, a cylindrical socket provided with a bottom flange and two opposite notches and two opposite hooks on the flange, the hooks being adapted to pass under the heads of the screws.



NO. 515,342.—ARC LAMP.

515,488. ELECTRIC MOTOR; C. Doriot, Philadelphia, Pa. Application filed March 11, 1893. The combination with the motor frame having a base portion projecting at one side of belt guide pulleys mounted on the projecting portion.

515,502. SECONDARY BATTERY; L. B. Rowley, Ashland, Wis. Application filed Feb. 7, 1893. A secordary battery electrode, consisting of the combination of a series of tubes, horizontally disposed, and two uprights, by which the tubes are supported, a space being left between the adjacent tubes for the circulation of the electrolyte.

515,503. AUXILIARY FIRE ALARM TELEGRAPH SYSTEM; J. Sachs, New York, N. Y. Application filed Feb. 15, 1893. This comprises a box having signal sending devices, a signal box having similar devices, and main and auxiliary circuits, both of which enter both of the boxes. (See illustration.)

515,531. SWITCH AND CIRCUIT FOR TELEPHONE EXCHANGES; J. J. O'Connell, Chicago, Ill. Application filed April 17, 1893. The combination with a plug cord of a switch or key having a part extending into position to be shifted by the cord as the latter is moved.

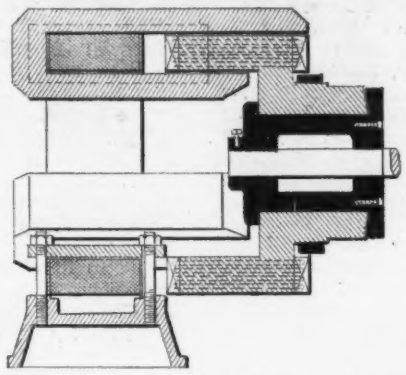
515,572. CONDUIT ELECTRIC RAILWAY; J. A. Cassidy and W. A. Butler, New York, N. Y. Application filed Aug. 24, 1892. In combination with a car, an electric contact bar, pendulum contact levers arranged within a conduit and mounted in protective boxes, and toggle mechanism connecting the bar to the car and for elevating and lowering the bar.

515,589. SIGNALING APPARATUS; O. D. and M. A. Kleinsteuber, Milwaukee, Wis. Application filed April 8, 1893. A steam whistle having controlling valve adapted to be operated by a lever arranged to act when released by an electric current.

515,606. INCANDESCENT LAMP SOCKET; R. C. Nourse, South Framingham, Mass. Application filed May 31, 1893. The combination of a head and base of insulating material, a metallic shank connecting the same, a contact plate affixed to the base, a contact spring affixed at one end to the head, and a rotary key rod in the head and provided at one end with a cam formed to depress the spring into contact with the contact plate when in one position and to permit the spring to separate from the plate when in another position.

515,613. CURRENT COLLECTOR FOR DYNAMOS; C. R. Roberts, Addison, Pa. Application filed Aug. 21, 1893. The combination with the commutator cylinder of a dynamo, of two endless belts of conducting material, and adjustable sheaves for supporting the same.

515,638. ELECTRIC ALARM SYSTEM FOR RAILWAY CROSSINGS; A. J. Wilson, Port Chester, N. Y. Application filed April 25, 1893. The combination of three independent track sections in line, a magnet for each section, the middle section magnet being incapable of operating when both end section magnets are operated, a signal circuit in the operative condition when the middle section magnet is not operated and an end section magnet is operated.



NO. 515,467.—ARMATURE FOR ELECTRIC MACHINES.

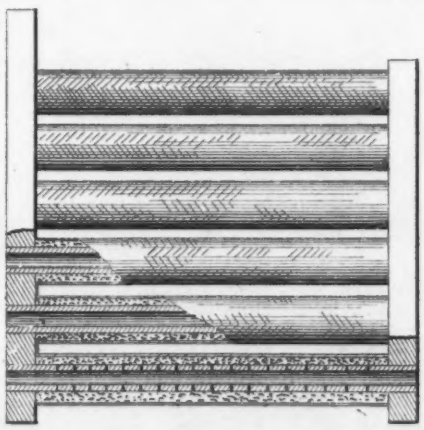
515,648. AUTOMATIC ELECTRIC RAILWAY SYSTEM; C. P. Breese, New York, N. Y. Application filed March 22, 1893. The combination of two track sections, two independent magnets and a relay magnet for each independent magnet in a compound circuit, one branch of which is controlled by the relay magnet itself and an independent magnet jointly, another branch of which is controlled by the other relay magnet, and a third branch of which is controlled by the two independent magnets jointly.

515,652. APPARATUS FOR ELECTRICALLY HEATING OR WORKING METALS; C. L. Coffin, Detroit, Mich.. Application filed Feb. 9, 1893. This comprises electrodes for the passage of current and an arc distributor with mechanism for changing its relation to the electrode during work.

515,654. ELECTRIC RAILWAY; B. F. Comstock, Decatur, Ill. Application filed April 13, 1893. The combination of a trolley arm provided with a yielding rod, of a plate having pointed ends and provided with rollers having wheels or flanges at their ends.

515,655. SIGNALING APPARATUS; J. W. English, New York, N. Y. Application filed Oct. 26, 1893. This comprises a plurality of targets arranged in series, each target comprising a common staff and oppositely projecting signal flags at opposite ends of the staff, a motor for each target geared to swing the same, and a containing case for the mechanism, the case having a single slight aperture before which the targets appear.

515,693. ELECTRIC HEATER; S. E. Nutting, Chicago, Ill. Application filed April 27, 1893. This comprises electric wires provided with terminals embedded in a non-conducting cement and between two layers of a flexible non-conducting material.



NO. 515,502.—SECONDARY BATTERY.

515,709. TELEGRAPHIC INSTRUCTOR; T. J. Houck and H. M. Browning, Baltimore, Md. Application filed Sept. 21, 1893. The combination of a pivoted operating lever, signal wheel, contact finger to make and break contact when the signal wheel is turned, a spring adapted when wound to turn the signal wheel, a lever connecting with a rock shaft, and means for regulating the speed of the signal wheel.

515,716. INSULATED PIPE COUPLING; G. Peeples, Philadelphia, Pa. Application filed June 5, 1893. This comprises an upper section with a threaded neck, a ring adapted thereto, and insulating material between the meeting faces of the rings.